Coho (*Oncorhynchus kisutch*) and Chum (*O. keta*) Salmon Visual Enumeration Surveys in Twenty-Six Lower Fraser Area Streams: 1999-2005

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COHO (*Oncorhynchus kisutch*) AND CHUM (*O. keta*) SALMON VISUAL ENUMERATION SURVEYS IN TWENTY-SIX LOWER FRASER AREA STREAMS: 1999-2005

by

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TABLE OF CONTENTS

1.0 INTRODUCTION **1**

2.0 METHODS **5**

- 2.1 COHO AND CHUM BIOLOGY 5
- 2.2 STREAM SELECTION 5
- 2.3 FIELD METHODS 5
- 2.4 ENVIRONMENTAL CONDITIONS 6
- 2.5 OBSERVER EFFICIENCY 6
- 2.6 STREAM RESIDENCE TIME 7
- 2.7 ESCAPEMENT ESTIMATES 8
- 2.8 ESCAPEMENT TRENDS 8

3.0 RESULTS **9**

- 3.1 COHO AND CHUM VISUAL ENUMERATION HISTORY 9
- 3.2 SURVEY LOCATIONS 9
- 3.3 SURVEY PERIODS 9
- 3.4 OBSERVER EFFICIENCY 9
- 3.5 RESIDENCE TIME 10
  - *3.5.1 Coho salmon 10*
  - *3.5.2 Chum salmon 10*
- 3.6 RESIDENCE TIME AND OBSERVER EFFICIENCY SENSITIVITY ANALYSES 12
- 3.7 ESCAPEMENT ESTIMATES AND TRENDS 13

4.0 DISCUSSION **16**

5.0 RECOMMENDATIONS **18**

6.0 ACKNOWLEDGEMENTS **19**

7.0 REFERENCES **20**

APPENDIX A **23**

- BARNES CREEK 24
- BLANEY CREEK 27
- CHILQUA CREEK (SLOUGH) 31
- COGHLAN CREEK 35
- HICKS CREEK (KAMP SLOUGH) 40
- HOPEDALE SLOUGH (CREEK) 45
- KANAKA CREEK 49
- KAWKAWA (SUCKER) CREEK 55
- LITTLE CAMPBELL (CAMPBELL) RIVER 60
- LITTLE STAWAMUS RIVER 65
- MASHITER CREEK 70
- McINTYRE CREEK 74
- NATHAN (GLEN, BEAVER) CREEK 79
- NORRISH (SUICIDE) CREEK 84
- NORTH ALOUETTE RIVER 90
- POST CREEK 95
- SALMON RIVER 99
- SERPENTINE RIVER (TYNEHEAD CREEK) 104
- SIDDLE (BELLS, TATHUM) CREEK 110
- SILVERDALE (SILVER) CREEK 115
- SQUAWKUM CREEK 121
- STREET CREEK 126
- WEST CREEK 130

WHONNOCK CREEK 135
WIDGEON CREEK 140
WORTH CREEK 145

APPENDIX 'B' 150

APPENDIX 'C' 151

APPENDIX 'D' 152

LIST OF FIGURES

Figure 1. Lower Fraser River (mouth to Barnston Island) streams assessed by the coho/chum visual enumeration survey (1999-2005) 2

Figure 2. Lower Fraser River (Barnston Island to Hope) streams assessed by the coho/chum visual enumeration survey (1999-2005) 3

Figure 3. Squamish Area streams visually assessed by the coho/chum visual enumeration survey (1999-2005) 4

Figure 4. Average observer efficiency (*n* = number of years assessed) for each stream described in this report for all years surveyed in order of smallest to largest observer efficiency 10

Figure 5. Tag depletion curves for four different chum tagging periods (T1-T4) and their associated residence time (R.T.) in Silverdale Creek, 2004 11

Figure 6. Escapement for different observer efficiency (O.E.) and residence time (R.T.) values used in the AUC calculation 12

Figure 7. Average escapement versus average densities for coho on LFA streams (1999-2004) 14

Figure 8. Average escapement versus average densities for chum on LFA streams (2001-2004) 14

Figure 9. Annual index of coho escapements from 1999 to 2004 for
a) all surveyed Lower Fraser Area streams (AUC estimates);
b) Salmon River/Coghlan (mark-recapture (MR) estimates);
c) Salmon River/Coghlan River (area-under-the-curve (AUC) estimates) 15

Figure 10. Annual index of chum escapements to Lower Fraser Area streams fron 2001 to 2004 for a) all surveyed Lower Fraser Area streams (AUC estimates); b) Harrison River (mark-recapture) 15

LIST OF TABLES

Table 1. Coho residence times estimated from area-under-the-curve and mark-recapture escapement estimates for the Salmon River and Coghlan Creek 11

ABSTRACT

Grant, S.C.H., Kalyn, S.M., Mahoney, J.E., and Tadey, J.A. 2007. Coho (*Oncorhynchus kisutch*) and Chum (*O. keta*) salmon visual enumeration surveys in twenty-six lower Fraser area streams: 1999-2005. Can. Tech. Rep. Fish. Aquat. Sci. 2727: vi + 154 p.

Visual enumeration surveys were conducted on 26 streams for coho and chum salmon in the Lower Fraser Area (Squamish to Hope, BC) from 1999-2005. Fish counts and observer efficiencies were estimated during weekly foot surveys for each stream and trapezoidal area-under-the-curve methodology was used to estimate escapement over a range of residence times (R.T.). Residence times were calculated specifically for Salmon River/Coghlan Creek coho using mark-recapture and visual survey data (average R.T. (1999-2004) = 5 days) and Silverdale Creek chum using results from a residence time tagging study (R.T. (2004) = 9 days). Average coho escapement across all streams and years assessed (1999-2005) was 859 (range: 17 - 2,286). Average chum escapement across all streams and years assessed (2001-2005) was 3,673 (range: 0 - 22,065). Escapement trends were calculated for streams with a minimum of two years of escapement data for coho (20 streams) and chum (16 streams) salmon. Coho escapement was relatively low for the years 1999, 2000, and 2005 (average $\rho_{\max}$: 0.3) compared to 2001, 2002 and 2004 (average $\rho_{\max}$: 0.7). Chum escapement was similar for the years 2001, 2002 and 2005 (average $\rho_{\max}$: 0.6). Key habitat characteristics were also documented for each segment in each stream assessed. This information includes substrate type, riparian vegetation, adjacent land-use, in-stream cover, large-woody-debris (LWD), and flow/gradient. Characterizing spawner escapement, densities, run timing, and distribution, and freshwater habitat for assessed streams assists with achieving the overall goal of the Department of Fisheries and Ocean's (DFO's) Wild Salmon Policy (WSP): to restore and maintain healthy and diverse salmon populations and habitats. Results from this report specifically address WSP sections one and two: monitoring and assessment of stock status and habitat status of wild salmon populations.

RÉSUMÉ

Grant, S.C.H., Kalyn, S.M., Mahoney, J.E., and Tadey, J.A. 2007. Coho (*Oncorhynchus kisutch*) and Chum (*O. keta*) salmon visual enumeration surveys in twenty-six lower Fraser area streams: 1999-2005. Can. Tech. Rep. Fish. Aquat. Sci. 2727: vi + 154 p.

Des dénombrements visuels des saumons cohos et kétas ont été effectués dans 26 cours d'eau de la région du bas Fraser (de Squamish à Hope, en Colombie-Britannique) de 1999 à 2005. L'efficacité des dénombrements de poissons et des observateurs pour chaque cours d'eau a été estimée dans le cadre de relevés hebdomadaires effectués à pied, et la méthode trapézoïdale de calcul de l'aire sous la courbe a été utilisée pour estimer l'échappée en fonction d'une gamme de temps de résidence. Les temps de résidence ont été calculés spécifiquement pour le saumon coho de la rivière Salmon et du ruisseau Coghlan, à l'aide de données de marquage-recapture et de relevés visuels (temps de résidence moyen de 1999 à 2004 = 5 jours), et le saumon kéta du ruisseau Silverdale, à l'aide des résultats d'une étude de marquage axée sur le temps de résidence (temps de résidence en 2004 = 9 jours). L'échappée moyenne de saumons cohos dans l'ensemble des cours d'eau et pour toutes les années évaluées (de 1999 à 2005) se chiffre à 859 (intervalle de 17 à 2 286). L'échappée moyenne de saumons kétas dans l'ensemble des cours d'eau et pour toutes les années évaluées (de 2001 à 2005) se chiffre à 3 673 (intervalle de 0 à 22 065). Les tendances en matière d'échappée ont été calculées pour les cours d'eau auxquels correspondent plus de deux ans de données sur l'échappée de saumons cohos (20 cours d'eau) et kétas (16 cours d'eau). L'échappée de saumons cohos a été relativement faible en 1999, 2000 et 2005 ($\rho_{\max}$ moyen : 0,3), comparativement à l'échappée en 2001, 2002 et 2004 ($\rho_{\max}$ moyen : 0,7). L'échappée de saumons kétas a été semblable pour les années 2001, 2002 et 2005 ($\rho_{\max}$ moyen : 0,6). Les caractéristiques clés de l'habitat ont également été documentées pour chaque tronçon de chaque cours d'eau évalué. Les données sur l'habitat portent notamment sur le type de substrat, la végétation riveraine, les utilisations des terres adjacentes, la couverture végétale en milieu aquatique, les débris ligneux grossiers ainsi que le débit et la pente. La caractérisation de l'échappée, de la densité, de la période de remonte et de l'aire de répartition des reproducteurs, ainsi que de l'habitat d'eau douce pour les cours d'eau évalués, facilite l'atteinte du but général de la Politique sur le saumon sauvage du ministère des Pêches et des Océans : de rétablir et de maintenir en bon état de santé et de diversité les populations de saumons et leur habitat. Les résultats du présent rapport portent précisément sur les sections 1 et 2 de la Politique sur le saumon sauvage : la surveillance et l'évaluation de l'état des stocks et de l'état de l'habitat des populations de saumons sauvages.

1.0 INTRODUCTION

The Department of Fisheries and Oceans uses three monitoring levels to assess wild Pacific salmon *(Oncorhynchus spp.)* populations in British Columbia. These include indicator, intensive, and extensive programs. Indicator systems use quantitative methods to enumerate spawning adults, juvenile production, and recruitment to adult stages. These systems provide accurate and precise estimates of spawner abundance and smolt production for a few selected populations. In addition, by applying coded-wire tags to emigrating smolts, harvest distribution, exploitation rate and freshwater and marine survival can be estimated. Such information is important in forecasting future abundance and understanding the biological process that determine harvest capacity; however, very few indicator systems are assessed due to their high project costs. The Salmon River fence is the only coho salmon (*O. kistuch*) indicator program conducted in the Lower Fraser Area (LFA). There are no indicator systems for chum salmon (*O. keta*) in the LFA.

To place the results from indicator studies in the context of the larger metapopulation, intensive and extensive assessments of adult salmon are conducted over a broader geographic area. Intensive assessments involve study designs that provide consistent indices of spawners between years. These assessments employ fence, mark-recapture, and visual survey techniques. Accuracy and precision is relatively high for escapement estimates produced by fence and mark-recapture projects. However, similar to indicator systems, very few of these programs are conducted due to their high associated costs. In the LFA, only chum on the Harrison River are assessed using mark-recapture (intensive survey) methods.

Visual surveys provide less precise (and cheaper) quantitative estimates of spawner abundance for a larger group of populations with more diverse productivities and utilizing a broader range of habitats. Consequently, visual surveys provide information on abundance trends that could not simply be inferred from the trends obtained from the fence and mark-recapture assessments of the more productive populations.

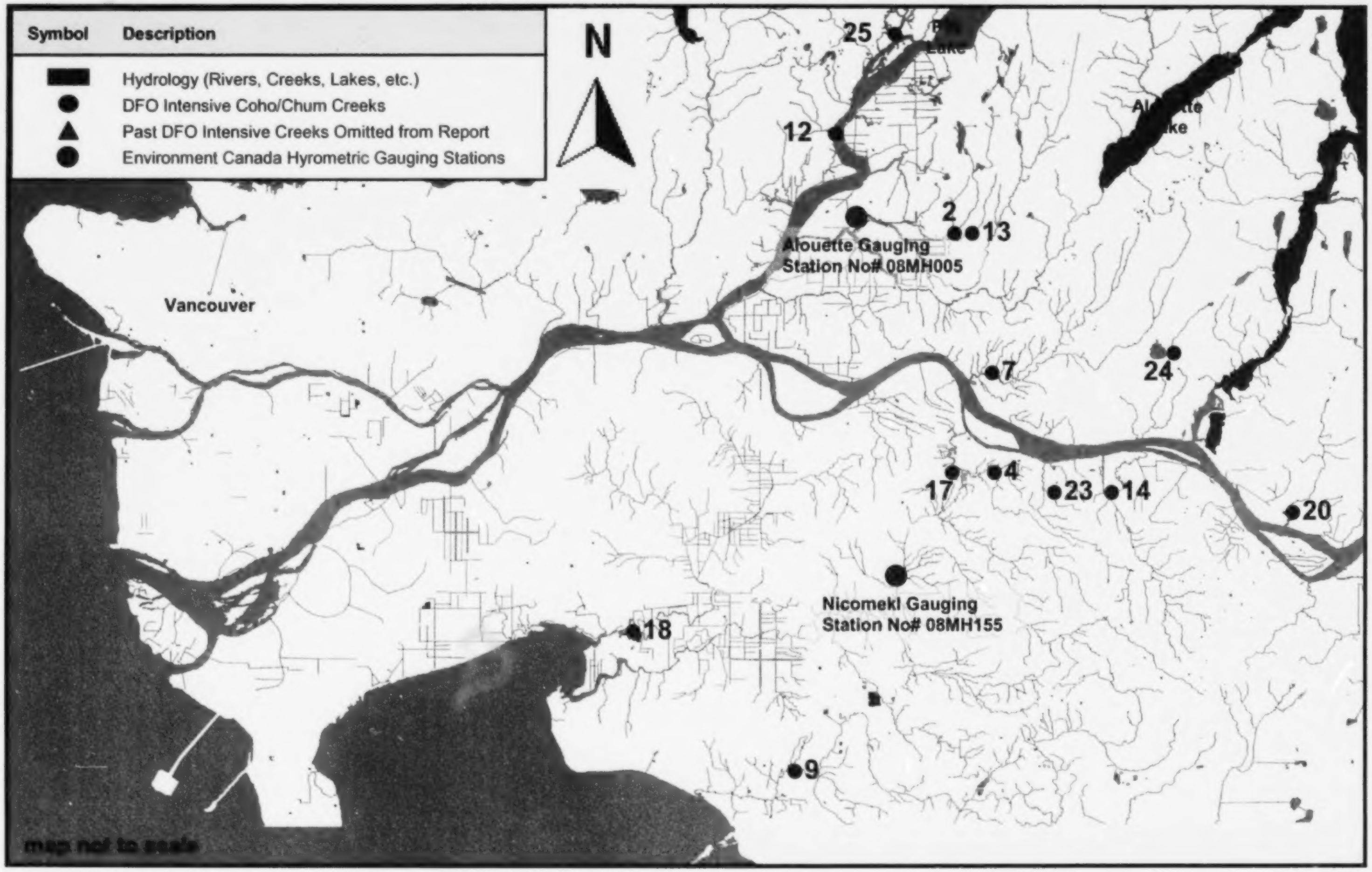
Visual counts of spawners throughout the spawning period and over the majority of their spawning range are widely used to produce area-under-the-curve (AUC) estimates of coho and chum escapements (Pirtle 1977; Ames 1984; English *et al.* 1992; Hill 1997; Parken *et al.* 2003). These types of programs dominate assessment methodologies in the LFA.

Extensive visual surveys deviate from intensive surveys in that they are qualitative assessments of relative abundance and distribution. Although conducted for much of the last century by enforcement officers (Farwell *et al.* 1987) currently no extensive programs are conducted in the LFA.

This report documents the intensive assessments (visual enumeration surveys) of LFA coho and chum populations in the Squamish and Fraser Rivers and Boundary Bay watersheds. The main objectives of this report are to 1) provide a reporting framework for visual enumeration surveys conducted in the Lower Fraser River; 2) assess long term escapement trends for coho and chum salmon; and 3) report on coho and chum spawning population abundance and distribution and to characterize spawning habitat obtained from these systematic surveys.

The report is structured to provide an overview of methodology, results, and discussion (Objectives 1 and 2) within the main body of the text. Coho/chum stream specific information (Objective 3) is addressed in **Appendix A.**

A subsequent report will use information compiled in this report to evaluate coho and chum population status in the LFA using visual enumeration survey results, in conjunction with the information collected by the Salmon River coho fence (indicator) program and the Harrison River chum mark-recapture. This objective will be achieved by identifying a group of populations (using a number of criteria) that will serve as a surrogate for the entire metapopulation.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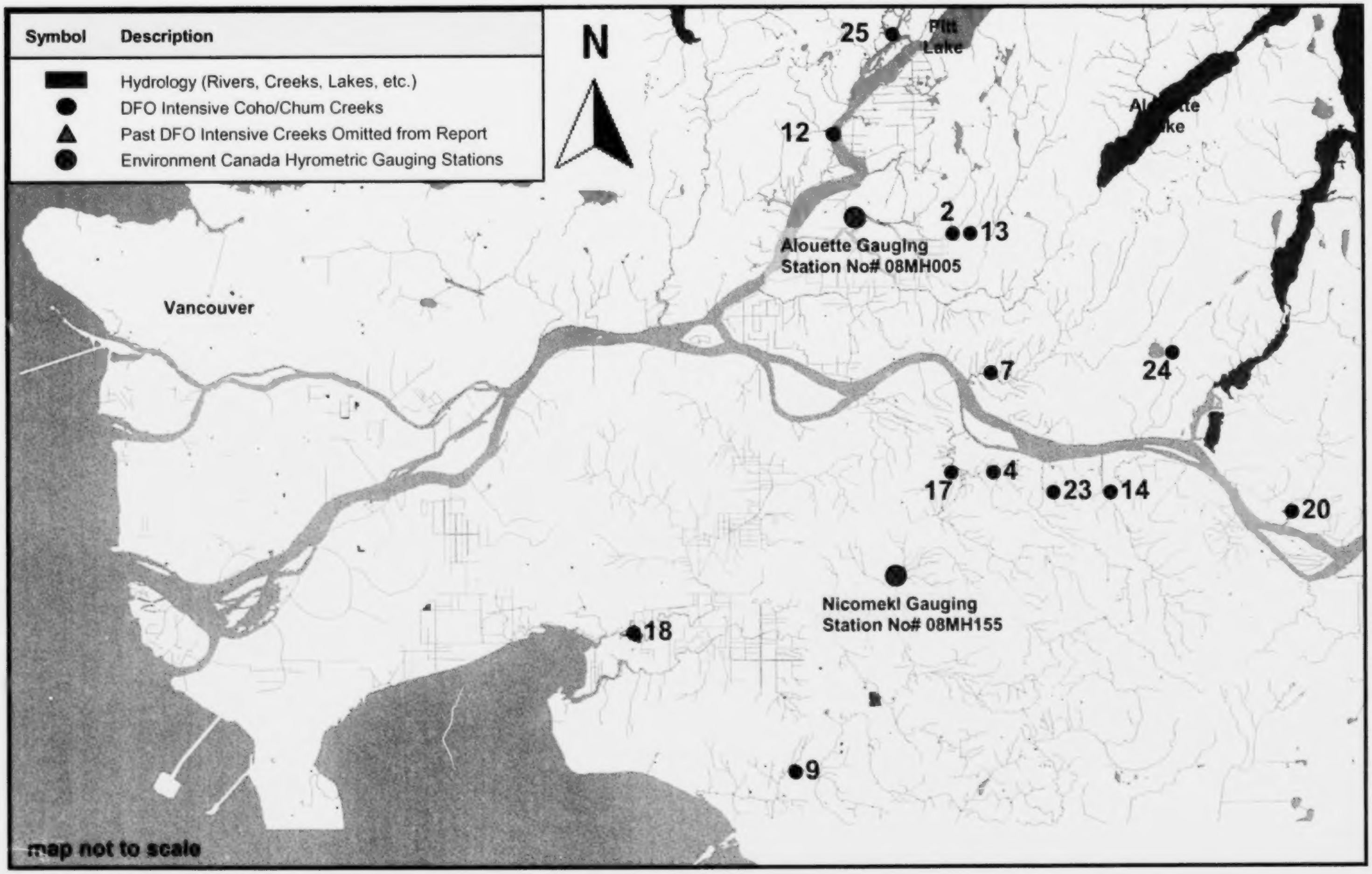
map not to scale

Figure 1. Lower Fraser River (mouth to Barnston Island) streams assessed by the coho/chum visual enumeration survey (1999-2005); bolded streams identified below occur on this figure.

1. Barnes
2. Blaney
3. Chilqua
4. Coghlan
5. Hicks
6. Hopedale
7. Kanaka
8. Kawkawa
9. Little Campbell
10. Little Stawamus
11. Mashiter
12. McIntyre
13. North Alouette
14. Nathan
15. Norrish
16. Post
17. Salmon
18. Serpentine
19. Siddle
20. Silverdale
21. Squawkum
22. Street
23. West
24. Whonnock
25. Widgeon
26. Worth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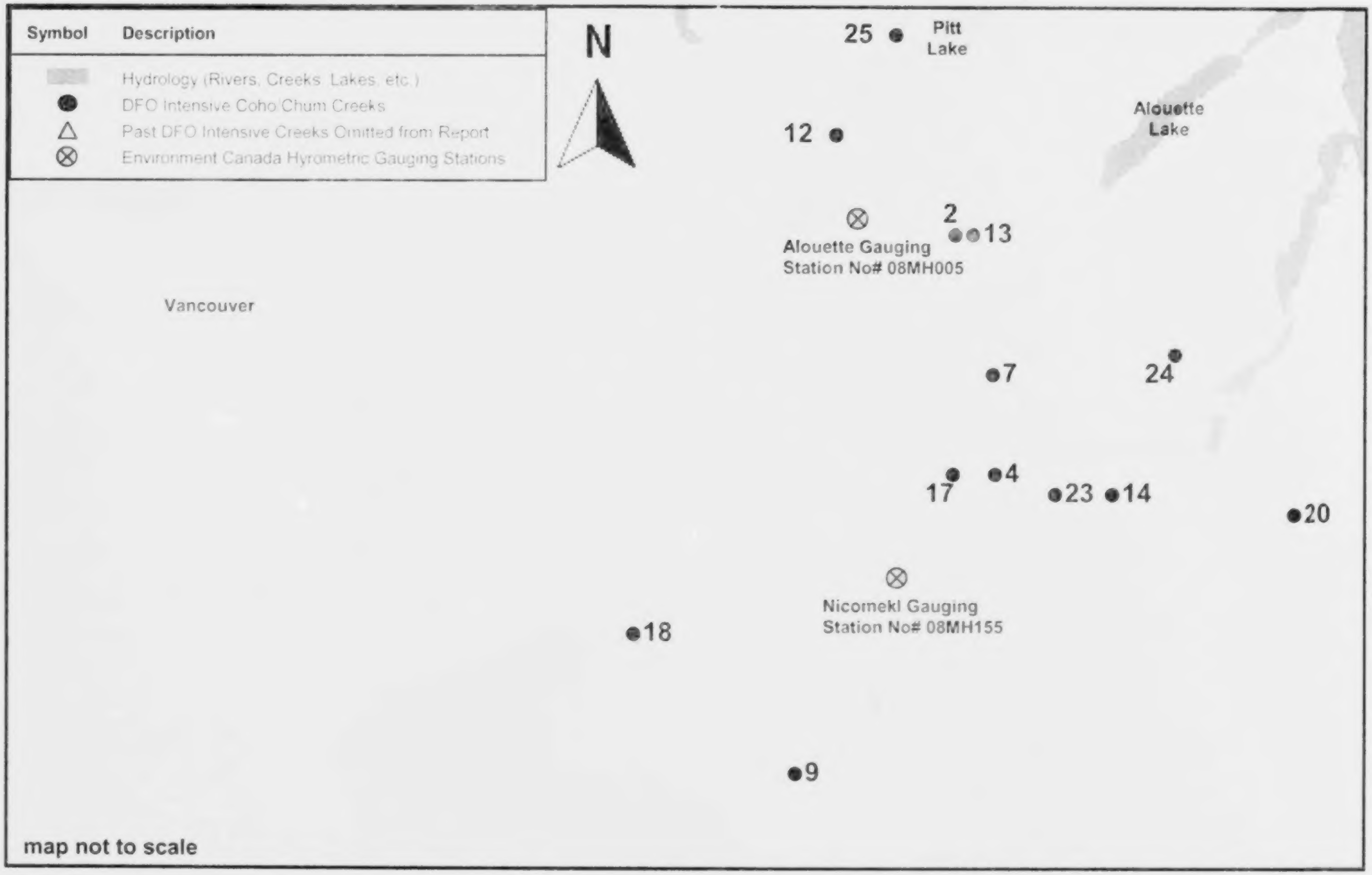
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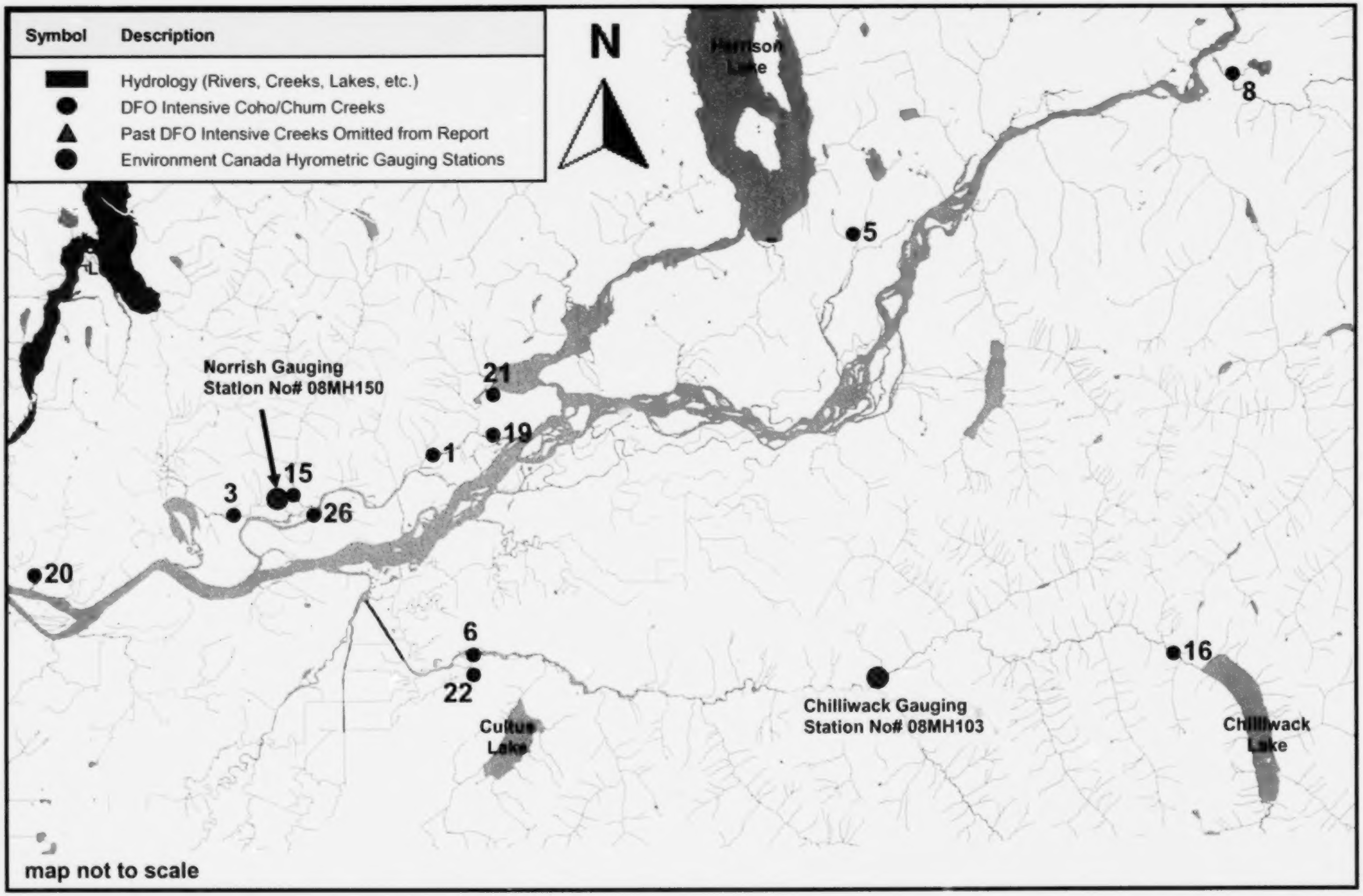
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Environment Canada Hyrometric Gauging Stations
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Norrish Gauging Station No# 08MH150
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Cultus Lake
Chilliwack Gauging Station No# 08MH103
16
Chilliwack Lake
map not to scale

Figure 2. Lower Fraser River (Barnston Island to Hope) streams assessed by the coho/chum visual enumeration survey (1999-2005); bolded streams identified below occur on this figure.

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16. Post
17. Salmon
18. Serpentine
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22. Street
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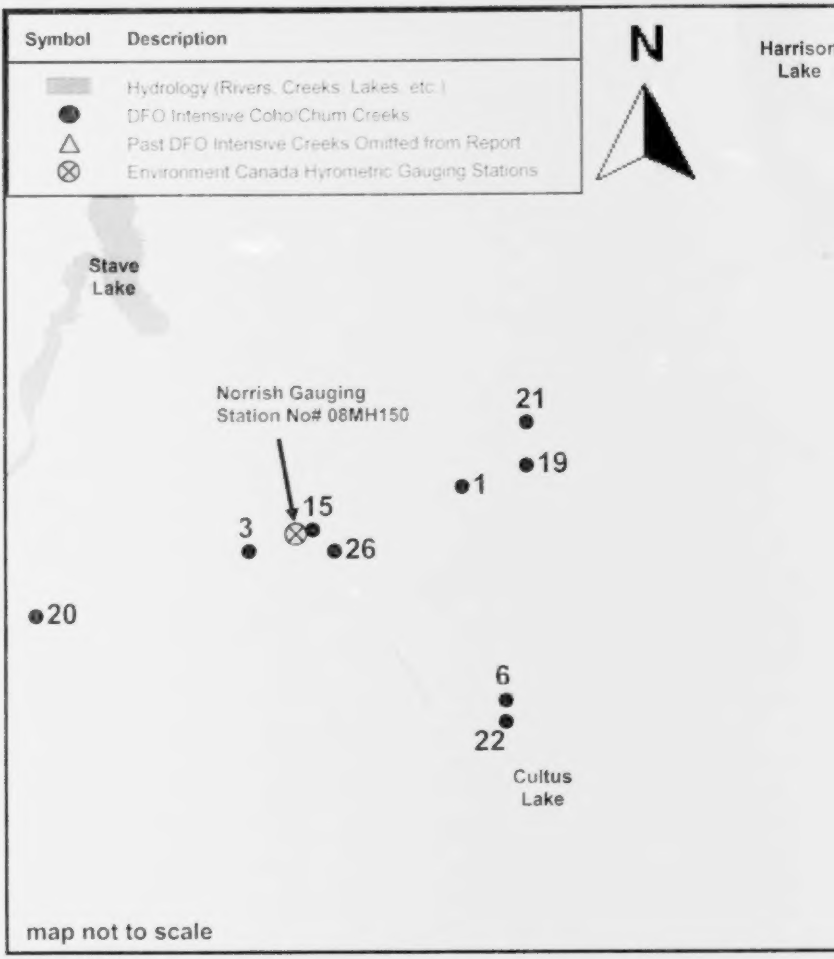
25. Widgeon
26. Worth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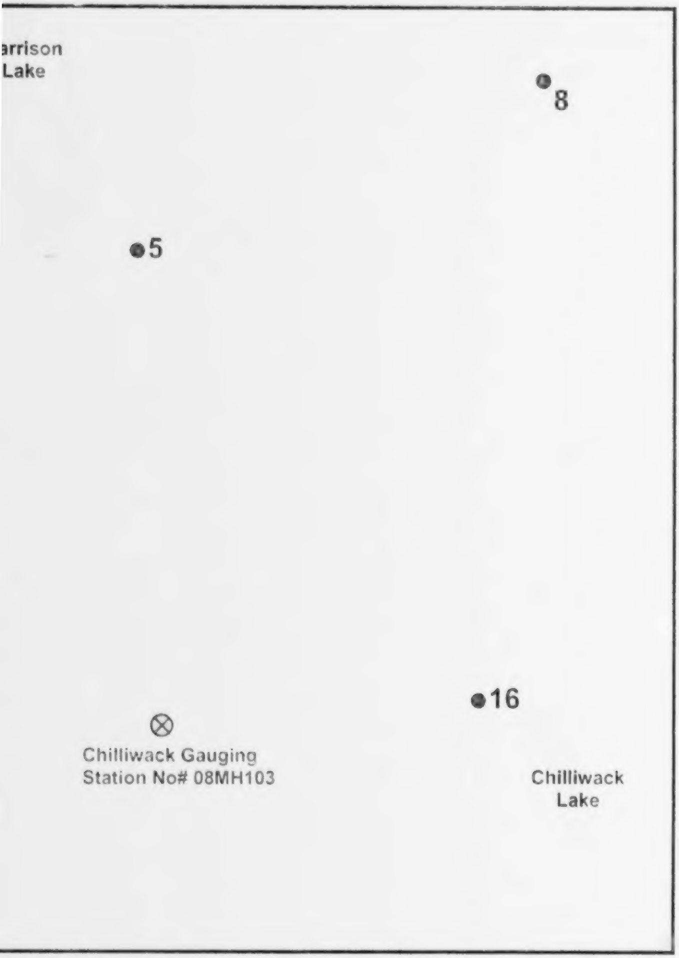
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2.0 METHODS

2.1 COHO AND CHUM BIOLOGY

In the Lower Fraser River, coho salmon are generally three year old fish spending two winters rearing in freshwater after emergence (as fry) and eighteen months in the marine environment (as juveniles) prior to retuning to their natal streams to spawn. Coho spawn in coastal streams, large rivers and headwater tributaries from October to February. Their arrival often coincides with high flows and heavy rainfall (Sandercock 1991). This species migrates considerable distances in freshwater and is capable of leaping up to 2 m to clear obstructions. As a result, coho are often widely distributed throughout a watershed (Sandercock 1991). During their upstream migration, coho seek refuge when disturbed, hiding under large woody debris (LWD), under-cut banks and deep pools.

Chum salmon in the Fraser River range in age from two to five year old fish, with the majority being four year olds (60%); three year olds and five years olds make up the majority of the remaining age-classes. Chum do not rear in the freshwater environment like coho salmon, migrating downstream to the Fraser estuary within hours or days of emergence from the spawning gravel. They spawn from September to mid-December in similar habitats to coho. Chum distribution tends to be more limited by barriers such as log jams and beaver dams since they do not exhibit leaping behavior (Salo 1991). They spawn in reaches with little cover at high densities and do not generally hide but rather disperse when disturbed.

For both species, the preferred spawning substrate is gravel smaller than 15 cm in diameter (Salo 1991; Sandercock 1991) to provide sufficient interstitial space for water flow and consequent oxygenation of the developing embryos. The presence of fines (diameters less than 6 mm) reduces embryo survival by restricting the water flow, which in turn decreases oxygen availability for developing embryos (Chapman 1998). Spawning nests (redds) are generally observed upstream of riffles where there is good circulation of oxygenated water through the gravel (Salo 1991; Sandercock 1991). Water velocities and water depths preferred for spawning coho range from, respectively, 30 to 55 cm/s and 10 to 20 cm. For chum, water velocities and depths range from 21 to 84 cm/s and 13 to 50 cm (Salo 1991; Sandercock 1991).

Quality of coho and chum spawning habitat is also correlated with the presence of LWD in a stream (Fausch and Northcote 1992). Large woody debris affects channel morphology by creating pools, collecting sediment, and reducing or redirecting stream flow (Crispen et al. 1993). It also provides instream cover for adults during spawning and juveniles during rearing (Bugert *et al.* 1991; Fausch and Northcote 1992) and habitat for aquatic invertebrates which are a key component of juvenile salmonid diets (Angermeier and Karr 1984). A large riparian zone is required to supply large woody debris to a stream.

2.2 STREAM SELECTION

Since not all streams in the LFA can be assessed due to financial and/or human resources constraints, several criteria were used to select streams for assessment. These criteria included selecting streams to provide broad geographic coverage in the area representing a range of coho and chum population sizes. Field logistics (crew accessibility) also limited the number of streams that could be selected. Hatchery enhanced systems were avoided where possible so that assessments were largely focused on wild only systems. Secondary factors used in stream selection included adjacent land-use, stream hydrology, habitat quality and quantity, and fish observability (observer efficiency).

2.3 FIELD METHODS

Weekly foot surveys are conducted by two-surveyor teams who access the streams by vehicle; the number of teams varying with annual funding. Survey schedules and locations are established preseason with the objective of surveying the entire run while optimizing effort by clustering streams by geographic area. Historical information on run timing for a particular stream is used to determine survey start and end dates **(Appendix B)**.

The surveyors generally work together for health and safety reasons; however, they may work on different segments while staying in contact by radio or cellular telephone. Longer streams (> 500 m) are divided into segments that are assessed relatively consistently each year. Segment boundaries are based on access points or transitions between different stream habitat types (e.g. benthic substrate, habitat complexity, or riparian vegetation). For consistency between surveys, segment boundaries are marked with flagging tape at the start of the season. To maximize fish observability, streams are walked in an upstream direction to decrease sediment and fish disturbance. Some streams, however, are walked downstream if logistics, glare or other factors are an issue. The surveyors use polarized glasses to reduce glare and peughs (long walking sticks with a metal hook attached to the bottom) to provide support in high water, probe in-stream cover for hiding salmon and collect carcasses for biological sampling. They use separate counters to keep track of the observed spawning chum and coho in each segment of a stream.

Data that are recorded on daily field data sheets **(see Appendix C)** include the date, stream name, surveyors' names, live and dead fish counts by species and segment, and environmental conditions.

Environmental conditions that may affect fish behaviour and/or fish observability are also recorded on data sheets. These include percent bankfull, water temperature and clarity (depth of visibility), brightness (light levels reaching the surface of the stream), percent cloudiness, and presence and intensity of precipitation. Carcasses are also recorded by species and segment and may be sampled for post-orbital hypural length (POHL), sex, percent spawn, carcass conditions, adipose presence/absence, CWT detection (where applicable), scales for ageing and operculum punches for DNA analyses.

Field data are returned to the office weekly where they are verified for completeness and legibility. Verified data are entered into a database and subsequently analyzed using area-under-the-curve methodology. Average annual coho and chum densities are calculated for each stream segment by dividing the average number of fish in each segment by the segment area. Segment area is calculated by multiplying the segment length by the average segment width. At the end of the season the data and escapement results are input into a central DFO database (nuSEDS V2.0).

2.4 ENVIRONMENTAL CONDITIONS

For in-season planning, water level data produced by Environment Canada are used. In-season, daily environmental conditions are monitored to determine whether or not a survey for a particular stream on a particular day is logistically feasible; high water levels increase health and safety risks and/or significantly reduce fish observability. On-line information provided by Environment Canada's real-time water level stations on representative rivers and streams are used to provide an indication of survey conditions (Environment Canada website accessed on February 2007: http://scitech.pyr.ec.gc.ca/waterweb/formnav.asp?lang=0). Gauging stations in the LFA are located on the following Rivers: Alouette, Nicomekl, Norrish, Chilliwack, and Squamish Rivers (Figure 1-3).

2.5 OBSERVER EFFICIENCY

Two factors are critical to the reliability of AUC escapement estimates: observer efficiency (O.E.) and residence time (R.T.). Observer efficiency is the proportion of salmon counted relative to the total number of salmon in the stream. Generally, fewer fish are counted during a survey than are actually present. Therefore if counts are not expanded using O.E., escapement estimates will be negatively biased (Irvine *et al.* 1992; Bue *et al.* 1998; Hilborn *et al.* 1999). Factors that affect the observability of fish can include weather conditions (water levels and flow rates), glare, habitat conditions (dark water, cutbanks, deep/dark pools, etc.), surveyor experience, species, and fish densities (Jones *et al.* 1998; Korman *et al.* 2002; Hetrick and Nemeth 2003).

Ideally, validation of O.E. should be conducted by comparing known counts with visual survey counts for all surveyors over a range of environmental and stream habitat conditions. However, since such studies are costly, subjective assessments of O.E. were used and calibrated among crew members in our study. These O.E. values are required to compare escapement estimates between systems and within systems intra- or inter-annually where a range of environmental conditions occur. Average O.E. for each stream and standard deviations presented in this report, therefore, only reflect subjective O.E. estimates rather than experimental error quantified from validation studies.

2.6 STREAM RESIDENCE TIME

Residence time (R.T.) ("survey life" or "survey area residence time") is the average time mature salmon spend alive in a survey area (Perrin and Irvine 1990; Irvine *et al.* 1992). Spawning fish counts (versus holding) are used to generate escapement estimates. Frequently an average R.T., compiled from data over different streams and years, is used in the AUC escapement calculation (Pirtle 1977; Beidler and Nickelson 1980; Ames 1984; Johnson and Barrett 1988). However, since considerable variation in R.T. can occur between systems and years due to differences in run timing, water temperatures, water flows, body size, fish densities, and migration distances, the use of an average R.T. can introduce bias to the escapement estimate (Van den Bergeh and Gross 1986; Perrin and Irvine 1990; Irvine *et al.* 1992). To improve the accuracy of AUC escapement estimation, R.T. should be calculated annually for each system surveyed (Perrin and Irvine 1990; English *et al.* 1992). However despite these recommendations, fiscal limitations frequently restrict the number of R.T. studies that can be conducted in any given year. For our visual enumeration program in the LFA, we conducted opportunistic R.T. studies for coho in the Salmon River-Coghlan Creek (Fort Langley, BC) from 1999 to 2004 and chum R.T. studies in Silverdale Creek, (Mission, BC) in 2004.

For coho, we used data from two existing studies conducted annually to opportunistically calculate a residence time; these two studies include the Salmon River-Coghlan Creek mark-recapture and visual survey projects. An average R.T. for coho was estimated by dividing the area-under-the-curve calculated from visual surveys (Equations 4 and 5) by the escapement estimated from mark-recapture results. Visual surveys were generally conducted weekly, upstream of the Salmon River fence and included both the Salmon River and Coghlan Creek; Coghlan Creek branches off of the Salmon River upstream of the enumeration fence in Williams Park.

In 2004 we conducted a R.T. study on Silverdale Creek for chum. Chum were captured at a fish fence located 945 m upstream from Silverdale Creek's confluence with the Fraser River. Fish were removed from the trap box, tagged with bright Petersen disc tags, and their sex, nose-fork length, and release condition (1-4) were recorded prior to release immediately upstream of the counting fence; for each tagging period a different color of tag was applied. During subsequent foot surveys, conducted upstream of the counting fence for the entire range of observed chum spawning, the number of tagged chum observed were recorded (ot_{ih}) and O.E. was estimated (oe_{ih}). Using the O.E. corrected counts (Equation 1), a tag depletion curve is plotted through time (t_i); the curve intercepts the x-axis on the date of tag application (English *et al.* 1992). To calculate R.T., the calculated area-under-the-tag-depletion curve (Equation 2) is divided by the total number of tags applied (rel_g^{-1}) for each tagging period (Equation 3).

$$tag_i = \sum_{h=1}^{L} ot_{tih} \cdot oe_{ih}^{-1}$$

Equation 1

$$auc_g = 0.5\sum_{i=1}^{n}(t_i - t_{i-1})\cdot(tag_i + tag_{i-1})$$

Equation 2

$$rt = auc_g \cdot rel_g^{-1}$$

Equation 3

The R.T.'s estimated from these assessments were used to calculate escapement for coho in both the Salmon River and Coghlan Creek and chum in Silverdale Creek. For all other systems where similar studies were not conducted, escapement was calculated over a range of R.T.'s. For coho, R.T.s used ranged from 9 to 13 days (11 d average) (Perrin and Irvine 1990). For chum, R.T.s used ranged from 8 to 12 days (10 d average) (Perrin and Irvine 1990).

2.7 ESCAPEMENT ESTIMATES

The trapezoidal area-under-the-curve (AUC) method was used to calculate escapement for a species in a given stream; equations are described below (equations 4-6). First the total fish present in a stream for each survey day is calculated by dividing the total fish observed by the O.E. (Equation 4) (Irvine *et al.* 1992).

$$p_i = \sum_{h=1}^{L} fo_{ih} \cdot oe_{ih}^{-1}$$

Equation 4

Where *L* is the number of segments (*h*) in each stream, fo_{ih} is the number of live fish observed during surveys in segment *h* on *i*th sampling day and oe_{ih}^{-1} is the O.E. (the proportion of the total number of fish present that are observed by the surveyor).

The number of fish observed for each survey (p_i) and the associated survey date (t_i) are then used to calculate the area-under-the-curve using trapezoidal approximation methods (Equation 5). For this calculation, surveys must start prior to when the first chum or coho are observed in a system, up until the run is complete and no more chum or coho are observed. When a survey does not start or end at a population size of zero, then regression methods on either the first two survey counts (if $p_i \neq 0$ for the first survey of the season) or last two survey counts (if $p_i \neq 0$ for the last survey of the season) are used to estimate the date when no fish were present in the system.

$$auc = 0.5\cdot\sum_{i=2}^{n}(t_i - t_{i-1})\cdot(p_i + p_{i-1})$$

Equation 5

The escapement estimate is calculated using the following equation:

Escapement = $auc \cdot rt^{-1}$

Equation 6

2.8 ESCAPEMENT TRENDS

Since the time series for coho and chum escapement estimated from visual counts was not continuous from 1999 to 2005, we used equations 7 and 8 to assess escapement trends for these years (Holtby 1999). For coho and chum, only streams with more than two years of escapement data were included in the annual escapement trend calculation. Chum were not assessed in 1999 and 2000 and, therefore, no trends are presented for these years.

Where $n_i \geq 2$:

$$\rho_{\max,ij} = E_{ij}\cdot(\max E_i)^{-1}$$

Equation 7

$$\rho_{\max,j} = \sum_{i}\rho_{\max,ij}\cdot n_j^{-1}$$

Equation 8

For each stream, the proportion of the maximum escapement is calculated for each year by dividing the escapement in each year by the maximum escapement in that stream across all years (Equation 7). Then for each year, the average proportion of the maximum escapement is calculated ($\rho_{\max}$) (i: stream; j: year; E_{ij}: observed escapement to the i^{th} stream in the j^{th} year; n_i: number of escapement records for the ith stream; $\rho_{\max ij}$: escapement to the i^{th} stream in the j^{th} year as a proportion of the maximum escapement to the i^{th} stream).

3.0 RESULTS

3.1 COHO AND CHUM VISUAL ENUMERATION HISTORY

Coho visual surveys in the LFA commenced in 1999 and core streams were enumerated consistently to 2005 (excluding 2003 due to funding limitations). Chum visual surveys were first assessed in 2001 opportunistically by the coho visual survey crews. Additionally, a few chum-targeted streams were added to the survey schedule. The chum data, however, was incomplete for escapement estimation purposes and was instead used to determine survey start dates in subsequent year's surveys. In 2002, the first complete chum visual survey program was conducted and continued to 2005 (excluding 2003). Results for all coho and chum streams enumerated from 1999 to 2005 are included in this report **(Appendix A).**

Streams that have been surveyed over the duration of the coho and chum visual surveys, but have been excluded from this report due to incomplete data sets include the following: Fourteen, Fifteen Mile and Peach Creeks (Chilliwack); Brackendale, Branch 100, Dryden, High Falls and Pilchuk Creeks (Squamish); Lagace Creek (Mission).

3.2 SURVEY LOCATIONS

For each stream surveyed, stream locations in the Fraser watershed, segment descriptions and lengths are summarized in **Appendix D**. Detailed descriptions are presented in the individual creek sections in **Appendix A.**

3.3 SURVEY PERIODS

Prior to the field season, information on the general start and end dates for coho and chum run timing for each stream surveyed is used for scheduling purposes. Summaries of survey periods and fish observed by assessment year is reported in **Appendix D.** To provide the most accurate AUC escapement, surveys should be conducted for the entire period coho and chum are present in a system; when the start and end counts are zero for both species. In most systems chum migrate first (early to mid-October), followed by coho (mid-October to late-October). Consequently, chum migration and spawning ends much earlier (late November to mid-December) than coho (early to late January). Schedules are designed so that each stream is visited weekly (7-day cycle), while remaining sufficiently flexible to accommodate weather conditions and crew related issues (time off, holidays, illness, etc.).

3.4 OBSERVER EFFICIENCY

Average O.E. (± standard deviation) for all assessed streams and years was 0.68 (± 0.12) (Figure 4). Streams with the lowest O.E.s included Little Campbell (0.20), North Alouette (0.56), Salmon (0.57) Rivers, and Norrish Creek (0.61). The assessed areas of these streams are among the largest of all surveyed streams. The Salmon River's assessed area was particularly large at 35,000 m^2 compared to the all-stream's average area of 10,000 m^2. Little Campbell River and Norrish Creek also were among the most flashy systems assessed, experiencing rapid increases in water levels in response to precipitation. Streams with the highest O.E. were generally the smallest and include Hicks, Worth, Squakum, and Barnes (on average 2,000 m^2 in area).

Differences in O.E. between streams can also be attributed to differences in the amount of in-stream cover (e.g. cutbanks and woody debris) that are used by salmon, particularly coho, to avoid detection. Other factors that can decrease O.E. include a system's exposure to sunlight (surface glare), substrate size, water colour and turbidity, and the number and densities of both target and non-target salmon species.

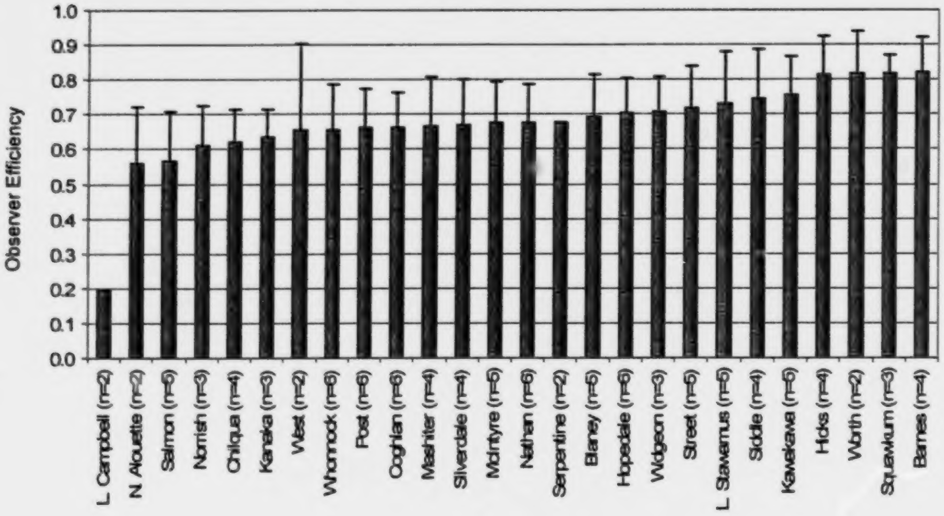

Figure 4. Average O.E. (*n* = number of years assessed) for each stream described in this report for all years surveyed in order of smallest to largest O.E..

3.5 RESIDENCE TIME

3.5.1 Coho salmon

Results from the Salmon River-Coghlan Creek mark recapture escapement estimates and separate AUC estimates were used to calculate annual coho R.T.'s for these streams from 1999 to 2004 (Table 1); fence counts were not used since the fence in all years was breached sufficiently to compromise the escapement estimate. Residence times for coho in the Salmon River-Coghlan Creek system (range: 3- 9 days) fall at the low end of the range reported in the literature (range: 3 to 15.1 d; average: 11.4) (Van den Berghe & Gross 1986; Perrin & Irvine 1990)(Table 3). These annually calculated R.T.'s were used to estimate escapement for all years visual surveys were conducted in both the Salmon River and Coghlan Creek. The estimated Salmon River-Coghlan Creek R.T.s could be negatively biased since the spawning area for coho in this system was considerable and not all areas were assessed (negatively biased AUC). An average R.T. across all years was used to estimate coho escapement in 2005.

3.5.2 Chum salmon

Peterson disc tags were applied to chum in four periods, T1 to T4, from October 24 to November 16, 2004 (Figure 5). Sixty-five tags were applied in each of T1 and T2, while 112 tags were applied in T3 and 84 tags were applied in T4.

T1, T2 and T4 were all compromised for reasons described below; only T3 produced a reliable estimate of R.T. In T1, the pin heads were smaller than the tag holes, resulting in observed tag loss. In all subsequent tagging periods this was corrected for by using tags with pin holes smaller than the pin heads and by double tagging fish to quantify tag loss during live surveys of tagged fish; no tag loss was observed in T2-T4. For T4 in particular, a large proportion of the chum tagged were in poor condition, as the timing of this tagging period coincided with the end of the chum run; several chum mortalities were observed shortly after tagging. The sex ratio for T4 was also skewed to a larger proportion of males versus females (3:1) compared to all other tagging periods that were approximately 1:1. Rainfall compromised all three of these tagging periods limiting the total number of visual surveys that could be conducted; three surveys were conducted for T1, two surveys for T2, and one survey for T4. All these factors, (tag loss (T1), small number of tags applied (T1, T2, and T4), poor release condition (T4), and rain events (T1, T2, and T4)), contribute to negatively biasing the R.T. estimated.

T3 produced the least biased estimate of R.T. for chum on Silverdale Creek (Figure 5). A relatively large number of tags were applied (112), no tag loss was observed, fish tagged were released in good condition, sex ratios were close to 1:1 and weather did not prevent scheduled visual surveys (five surveys in total were conducted) or limit the visibility of fish observed during these surveys. The R.T. produced from this tagging period (T3) was 7 days and was used to estimate escapement for all years chum were visually assessed in Silverdale Creek.

Table 1. Coho R.T.s estimated from area-under-the-curves and mark-recapture escapement estimates for the Salmon River and Coghlan Creek.

	1999	2000	2001	2002	2004	2005
Salmon River AUC (fish·days)	4,491	13,314	12,668	33,226	12,943	na
Coghlan River AUC (fish·days)	4,610	7,264	17,390	14,508	15,140	1,735
Mark recapture escapement	2,247	6,211	7,298	5,533	5,709	na
Calculated residence time	**4**	**3**	**4**	**9**	**5**	**na**

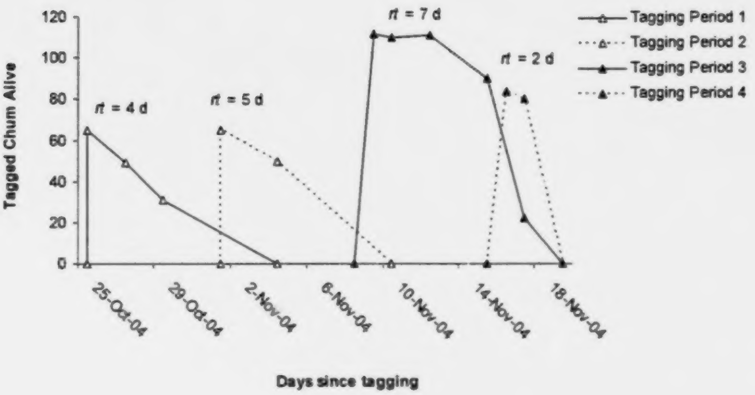

Figure 5. Tag depletion curves for four different chum tagging periods (T1-T4) and their associated residence time (R.T.) in Silverdale Creek, 2004.

3.6 RESIDENCE TIME AND OBSERVER EFFICIENCY SENSITIVITY ANALYSES

Since O.E. was not validated and R.T. was not assessed for each stream surveyed, average O.E. values used in the AUC calculation (Equations 1 to 3) may have biased the escapement estimates. To assess the sensitivity of the escapement calculation to O.E. and R.T., escapement was calculated over a range of O.E. values observed in our study (Figure 4) and R.T. values observed in the literature (Perrin and Irvine 1990). A hypothetical data set of visual counts over time was used in these calculations (Figure 6).

As both the O.E. and R.T. values decrease, the escapement estimates increase (Figure 6). The smaller both O.E. (< 0.7) and R.T. (< 6 d) the greater the differences in the estimated escapement for relatively small differences in O.E. and R.T. values (see shaded circle on Figure 6). Therefore, in systems with both poor fish observability (low O.E.) and relatively short target-species R.T.s, escapement estimates can be significantly biased even for small differences between the true and estimated O.E. and R.T. values. Although not validated, populations in our study with low O.E. values (Figure 4: Little Campbell, North Alouette and Salmon Rivers, and Norrish Creek) may be particularly susceptible to biased escapement estimates (e.g. compared to systems with higher O.E. values (Figure 4: Hicks, Worth, Squakum, and Barnes Creek). This bias will be particularly great when the population's true R.T. is small.

The escapement estimate is particularly sensitive to R.T. values. At small residences values there is a greater difference in estimated escapement over a range of O.E. values. At small O.E. values there is a comparatively smaller difference in estimated escapement over a range of R.T. value (Figure 6).

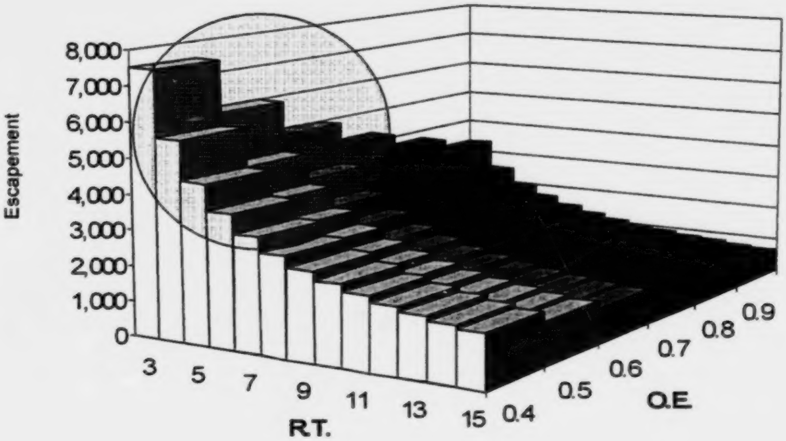

Figure 6. Escapement for different observer efficiency (O.E.) and residence time (R.T.) values used in the AUC calculation.

3.7 ESCAPEMENT ESTIMATES AND TRENDS

Average coho escapement across all streams and years assessed (1999-2005) was 859; the escapement range was from 17 (Street Creek) to 2,286 (Widgeon Creek). Average coho density was 0.038 fish/m^2; the density range was from 0.001 fish/m^2 (Street Creek) to 0.31 fish/m^2 (Hicks Creek). Densities for all streams were not correlated with escapement (*n*=25, r^2=0.11, P=0.10). Average coho densities for most streams were relatively low at less than 0.10 fish/m^2, with the exception of the following two streams: Hicks (0.31 fish/m^2) and Barnes (0.22 fish/m^2) (Figure 7).

Average chum escapement across all streams and years assessed (2001-2005) was 3,673; the escapement range was from 0 (Whonnock, Post, and Siddle Creeks) to 22,065 fish (Norrish Creek). Average chum density was 0.098 fish/m^2; the density range was from 0.000 fish/m^2 (Whonnock, Post, and Siddle Creeks) to 0.44 fish/m^2 (Squawkum Creek). Densities for all streams were considerably more variable for chum and were positively correlated with escapement (*n*=25, r^2=0.26, P=0.008) (Figure 8).

Escapement trends were calculated for streams with a minimum of two years of escapement data for coho (20 streams) and chum (16 streams) salmon. Coho escapement was relatively low for the years 1999, 2000 and 2004 (average $\rho_{\max}$: 0.3). Escapement was highest from 2001 to 2005 (average $\rho_{\max}$: 0.7) (Figure 9). The Salmon River is the LFA indicator stream for coho and is used to provide information on coho harvest distribution, exploitation and survival rates. However, as an indicator of LFA escapement trends, there is a poor correlation between the Salmon River and the visual survey trends for all assessment years (*n*=5, r^2=0.18, P=0.5) (Figure 9).

Chum escapement was similar for the years 2001, 2002 and 2005 (average $\rho_{\max}$: 0.6) (Figure 10). In addition to the stream surveys, the Harrison River mark recapture is another intensive escapement study conducted on chum salmon in the LFA. For chum salmon there is also a poor correlation between the Harrison River and the visual survey trends for all assessment years (*n*=4, r^2=0.05, P=0.8) (Figure 10).

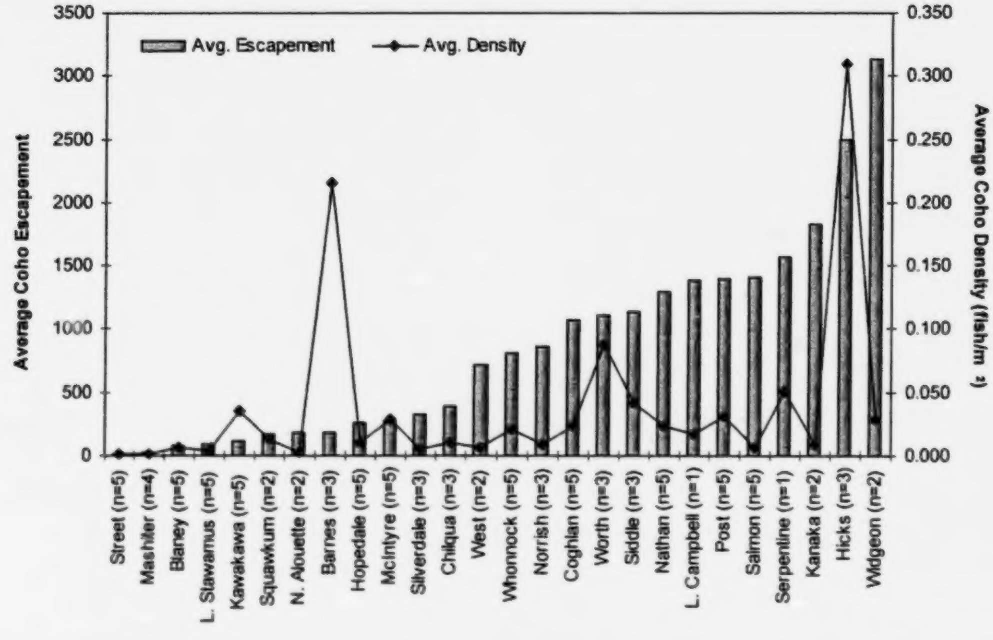

Figure 7. Average escapement (grey bars) versus average densities (black lines) for coho in LFA streams (1999-2005).

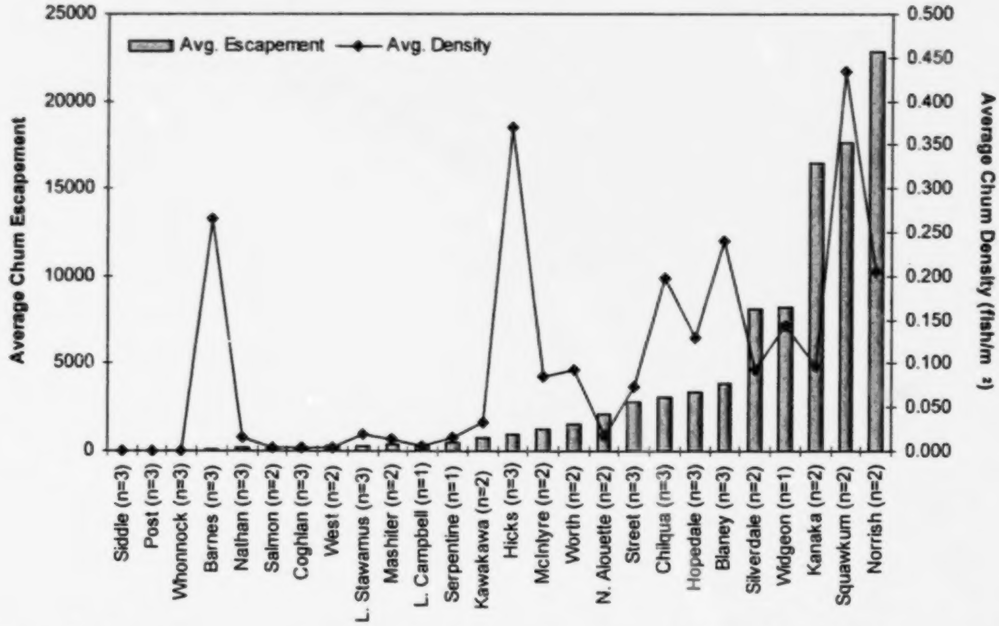

Figure 8. Average escapement (grey bars) versus average densities (black lines) for chum in LFA streams (2001-2005).

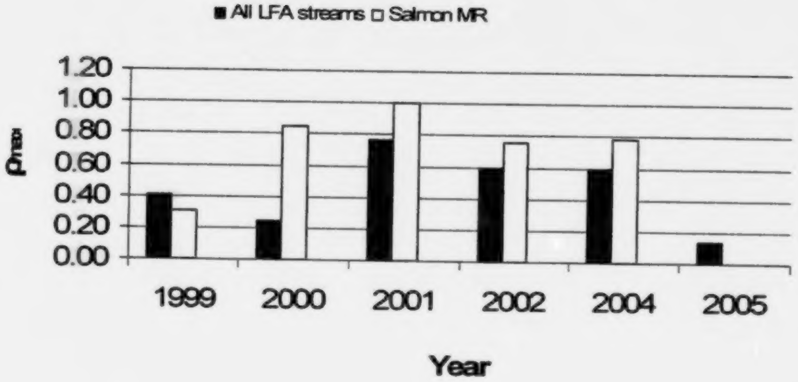

Figure 9. Annual index of coho escapements from 1999 to 2004 for a) all surveyed Lower Fraser Area streams (AUC estimates) (black bars); b) Salmon River/Coghlan (mark-recapture (MR) estimates) (white bars). Due to funding constraints, there was no mark-recapture assessment of the Salmon/Coghlan system in 2005.

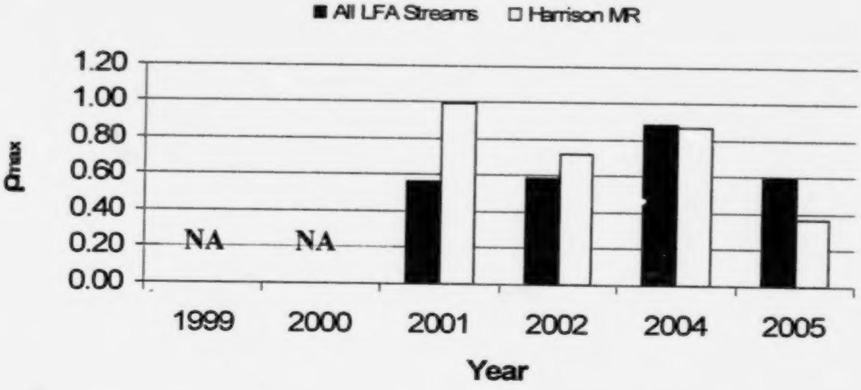

Figure 10. Annual index of chum escapements to Lower Fraser Area streams from 2001 to 2004 for a) all surveyed Lower Fraser Area streams (AUC estimates) (black bars); b) Harrison River (mark-recapture) (white bars).

4.0 DISCUSSION

Shifts in Pacific Salmon abundance have been linked to changes in ocean climate and productivity known as regime shifts (Francis & Hare 1994; Beamish *et al.* 2000). Key climate-ocean indices used to detect regime shifts include the Aleutian Low Pressure Index (ALPI), Arctic Oscillation (AO) and Pacific Decadal Oscillation (PDO) (Beamish *et al.* 2004). In coastal British Columbia, increased ocean productivity and salmon survival generally occur during negative index phases and, conversely, decreased ocean productivity and salmon survival occur during positive index phases. Climate-ocean indices have provided evidence for major regime shifts in 1989 (1990-1998: positive) and 1998 (1999-2003: negative). On Canada's Pacific coast, salmon abundance generally decreased from 1990-1998 and subsequently increased from 1999-2003; returns of Pacific Salmon were particularly high in 2000 and 2001 (Beamish *et al.* 1999; Beamish *et al.* 2000; Beamish *et. al* 2002; Beamish *et al.* 2004). From 2004-2006, the ocean-climate appears to have shifted again to a positive phase which should result in decreased ocean productivity and salmon survivals (Fisheries and Oceans Canada 2005).

Changes in ocean productivity should particularly affect salmon survival in their first year of ocean life when they are smallest and therefore most vulnerable to size-dependent mortality mechanisms such as predation and starvation (Miller *et al.* 1988; Grant and Tonn 2002). The faster fish grow in their first year of life, the less time they will spend in smaller more vulnerable sizes (Miller *et al.* 1988). Therefore, years of increased ocean productivity should increase food availability and consequently, growth rates and survival of fish.

Ocean productivity, therefore, can affect coho survival particularly in the approximately one and a half years prior to spawning when they first enter the marine environment. Although total returns are not estimated for the individual streams in the Lower Fraser visual survey program, escapement trends appeared to have tracked major shifts in ocean productivity. Across all years assessed, escapements were low in 1999 and 2000 (average $\rho_{\max}$: 0.3), highest from 2001 to 2004 (average $\rho_{\max}$: 0.7), returning to low escapements again in the final assessment year of 2005 ($\rho_{\max}$=0.1). Coho escapement in all streams and years assessed (1999-2005) ranged from 17 to 2,286 fish (R.T.= 11 d) and densities were 0.038 fish/m^2. Until longer term data sets are available for these streams, however, it will be difficult to definitively correlate ocean productivity to shifts in coho spawner abundance.

Escapement trends between the Salmon River and LFA visual surveys in the year 2000 appeared to be the least correlated, with all other years tracking more closely. Until more years are assessed, however, the Salmon River cannot be used as an overall indicator for coho escapement trends in the LFA.

Most chum in the Lower Fraser are four year old fish that spend almost their entire life-history after emergence from the gravel in the marine environment. Trends in observed escapement for chum, therefore, should be largely attributed to ocean productivity conditions (food availability) three and a half years prior to their return, when the majority of these fish are in their first year of growth. However, contributions of marine survivals of three year old chum and five year old chum may confound associating observed escapement trends with shifts in ocean productivity. In addition, similar to coho, no stream-specific catch information is available which also may mask environmental signals affecting escapement trends.

Unfortunately, at present, the time series for chum salmon escapements in the Lower Fraser are available only from 2001 to 2005. For these years, chum escapement was relatively constant (average $\rho_{\max}$: 0.7); the highest escapement year was 2004 ($\rho_{\max}$: 0.9). No ageing data was collected for these streams so it is not possible to partition escapements into associated ages. Chum escapement in all streams ranged from 0 to 22,901 fish (R.T.= 10 d) and densities were more variable than coho ranging from 0.000 to 0.435 fish/m^2.

The Harrison River chum mark-recapture is another intensive assessment (in addition to the visual surveys) of one of the largest populations of chum in the Fraser watershed. Similar to the Salmon River for coho, the Harrison River study is also not significantly correlated with the LFA visual survey escapement trends (n=3, r^2=0.04, P=0.9). Due to the small sample size, data from more years need to be compared to determine if the Harrison River can be used as an indicator of chum escapement trends in the LFA.

Escapement estimates calculated using trapezoidal AUC methodology can be biased if survey periodicity is inadequate and if unvalidated O.E.s and R.T.s are used (Beidler and Nickelson 1980; Ames 1984; Johnson and Barrett 1988). In our surveys, enumeration is typically conducted weekly, so periodicity should be sufficient for escapement estimation purposes since R.T. for chum and coho is, on average, longer than seven days. However, since resources were not available to conduct stream-specific annual R.T. studies, our escapement estimates were calculated for a range of R.T.s rather than a single point estimate.

In addition to changes in ocean productivity and its affects on salmon survival in the marine environment, the quality of freshwater habitat affects survival in the freshwater environment. The combination of both the freshwater and marine survivals (including harvesting) will determine the number of salmon that return.

Stream habitat characteristics in this report were described for all 26 streams assessed. Stream habitat quality affects the survival of incubating eggs and alevins for both coho and chum salmon. After emergence, however, habitat quality in the freshwater environment is only critical for coho salmon that rear in the freshwater for one year; chum salmon migrate to the Fraser estuary within hours to days of emerging from the spawning gravel.

For all streams, relative abundance of spawning habitat was documented in **Appendix A** of this report. Spawning habitat was characterized by unembedded gravel less than 15 cm in diameter. This allows for appropriate water flow around incubating eggs to supply oxygen and remove metabolites. To document the quality of the stream habitat for spawning, egg/alevin incubation, and juvenile rearing the following information was recorded: the presence of absence of riparian vegetation, adjacent residential, agricultural or road land-use, in-stream cover, stream bank erosion, garbage, and flow stability. This information can be used to identify stream segment spawning/rearing habitat that require restoration to meet the "Net Gain" in productive capacity of fish habitats in the "DFO Policy for the Management of Fish Habitat". It can also be used in future studies to correlate changes in fish productivity with freshwater habitat changes required as a component of DFO's Wild Salmon Policy Strategy 2: Characterization and Assessment of Habitat Status.

The most critical component of any intensive visual enumeration project is to survey the same streams annually using consistent survey methodologies. This report provides a clear framework to base future studies on to ensure consistency in the segments walked and methods used to estimate escapement for coho and chum in the LFA, which is necessary to track escapement trends for coho and chum over a broad geographic area through time. This report provides a framework for future studies conducted by DFO in the LFA on visual enumeration studies, documents information on habitat and escapement trends for representative streams in the area necessary for stock assessment, resource management, and habitat assessment purposes, and provides some recommendations for future studies in the LFA to improve escapement estimates for these systems required for reliably assessing stock status.

5.0 RECOMMENDATIONS

To develop a standardized assessment framework for all coho and chum visual enumeration surveys conducted in the Pacific Region, the development of the following are required: 1) stream selection criteria; 2) standardized field methodology; 3) standardized and systematic R.T. studies and O.E. validation studies; and 4) an analytical tool to calculate escapement that incorporates uncertainty into the estimate.

1) Since not all streams in a particular Area (Fraser Area, North Coast, South Coast) can be assessed due to financial and/or human resources constraints, standardized criteria need to be developed for the selection of streams in designated areas. In our coho/chum visual survey program, criteria used to select streams included geographic location, population size, historical assessments, logistics, minimizing assessment of hatchery enhanced systems, productivity, adjacent land-use, stream hydrology, habitat quality and quantity, logistics/costs, and fish observability (O.E.). By establishing more detailed and systematic criteria, streams in a particular area can be prioritized for coho and chum assessment to maximize the cost/benefit of visual enumeration programs. If new resources become available, then new streams can be selected based on their priority ranking.

These assessment criteria could also be used in the selection of streams for an extensive visual survey program. Extensive surveys complement intensive visual enumeration programs by achieving a broader spatial perspective on species distribution and relative abundance and to link this type of information to stream habitat characteristics and adjacent land-use. Given the major land-use changes (e.g. increasing urbanization) in the Lower Mainland and broader regional and global climate changes, tracking these shifts over a broader geographic range will be a critical component to evaluating the stock status and habitat status of salmon species in the watershed.

2) Streams that are surveyed currently in the Pacific Region employ a range of field methods that vary between programs. Discrepancies between programs include conducting complete counts of coho and chum over their entire stream distribution versus index counts (coverage of randomly selected stream areas). Using either complete or index methods, some programs enumerate spawning fish only and others enumerate both spawning and holding fish. Other discrepancies between existing programs include counting live versus dead (carcass counts) fish, the frequency of surveys (weekly to monthly), the use of O.E. (not all programs use O.E. when counting fish), and the values used for coho and chum R.T. In order to compare visual enumeration survey result from different programs it will be necessary to develop a similar field approach between all Pacific Region programs.

3) In addition to the development of standardized field methods for coho and chum enumeration, both R.T. and O.E. used in the AUC escapement calculations require field verification. Recent studies have found that R.T. can vary considerably among streams within a particular year and also among timing groups of a particular run; salmon entering a stream early tend to remain longer (Perrin & Irvine 1990; Irvine & Bailey 1999). Therefore, to improve the accuracy of escapement estimates using AUC methods, stream-specific R.T. should be estimated over the entire duration of a spawning run (English *et al.* 1992). Although it would be prohibitively expensive to conduct R.T. studies for each stream in our survey area, a cost-effective alternative would be to conduct R.T. studies on several representative streams throughout the area and apply these R.T.s to the escapement calculations for similar streams.

Observer efficiency is the second variable in the AUC escapement calculation that should be validated in future years. It should be validated over a range of environmental (water levels and flow) and habitat conditions (deep pools, shallow riffles/runs, cutbanks, etc.) for each crew member. One method for validating O.E. is to set up two temporary fences downstream and upstream of a representative stream segment. The actual number of fish in the segment could be calculated (the number of fish moving past the upstream fence subtracted from the number of fish moving past the downstream fence). Collapsible fish counting fences could be set up for several different stream segments representing a range of habitat conditions observed throughout the study period during different environmental conditions (high water levels/fast water flow versus low water levels/slow flow). Alternatively, fish could be tagged with dull Petersen disc tags and within 24 hours of tagging surveyors could walk upstream of the tagging site and the O.E. could be calculated (Equation 9). The number of tags observed versus the number of tags applied could be used to estimate O.E. over a range of conditions and for different surveyors.

$$O_i = r_i \cdot m_i^{-1}$$

Equation 9

For each trial *(i)*, *O* is the O.E., *r* is the number of fish marked that were counted in the subsequent foot survey, and *m* is the total number of fish marked (Hetrick and Nemeth 2003).

4) Even if more accurate R.T. estimates are obtained and O.E. is validated for each crew member, the trapezoidal AUC algorithm used in the present study does not incorporate uncertainty associated with these values into the escapement estimate (Hilbourn *et al.* 1999). One approach that incorporates uncertainty in the escapement estimate is the maximum likelihood method (Hill 1997) that generates escapement estimates bounded by confidence intervals. The maximum likelihood method could be used particularly for chum that arrive in a single pulse over a relatively narrow time period; their run timing can be modelled using a normal distribution (Hilborn *et al.* 1999; Su *et al.* 2001). For coho that generally arrive in several pulses in response to increasing water levels and have a protracted run timing, other distributions could be used (e.g. beta or pulsed distributions) (Hilborn *et al.* 1999). An alternative approach to the maximum likelihood method for incorporating uncertainty in the AUC calculation is the bootstrap procedure for the trapezoidal AUC method described by Parken *et al.* (2003). By generating more accurate estimates of R.T. and O.E. and incorporating uncertainty in these values, stock status can be more reliably assessed (Walters & Ludwig 1981; Hilbourn 1992).

In future R.T. studies, the tagging study should be repeated on Silverdale Creek and several other systems for both coho and chum to generate more accurate R.T. estimates that can be used to estimate escapement for coho and chum in LFA streams.

5) The habitat assessment component of this visual survey program can be expanded as indicators and benchmarks are finalized through the Wild Salmon Policy. These habitat characteristics can then be added to future assessments to monitor and assess habitat status and correlate changes in habitat quality with shifts in salmon productivity.

In the LFA, the largest visual enumeration projects in terms of the number of streams surveyed, in addition to DFO Stock Assessment surveys, are projects conducted by local First Nations. First Nations that conduct relatively large visual surveys projects for coho and chum include Squamish First Nation (1996-2005), Tsleil-Wateuth First Nation (2000-2005), Chehalis First Nation (1984-2005), Mount Currie First Nation (2002-2005), and Douglas First Nation (2002-2005). By employing a common framework to all assessment programs in the Region, results from different programs can be compared and used collectively to provide information on coho and chum stock status.

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APPENDIX A

INDIVIDUAL CREEK RESULTS

Extensive Program Creeks 1999-2005:

Barnes Creek
Blaney Creek
Chilqua Creek (Slough)
Coghlan Creek
Hicks Creek (Kamp Slough)
Hopedale Slough
Kanaka Creek
Kawkawa (Sucker) Creek
Little Campbell (Campbell) River
Little Stawamus River
Mashiter Creek
McIntyre Creek
Nathan (Glen, Beaver) Creek
Norrish (Suicide) Creek
North Alouette River
Post Creek
Salmon (Deleeuw) River
Serpentine River (Tynehead Creek)
Siddle (Bells, Tathum) Creek
Silverdale (Silver) Creek
Squawkum Creek
Street Creek
West Creek
Whonnock Creek
Widgeon Creek
Worth Creek

BARNES CREEK

Watershed Code: 100-0724-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

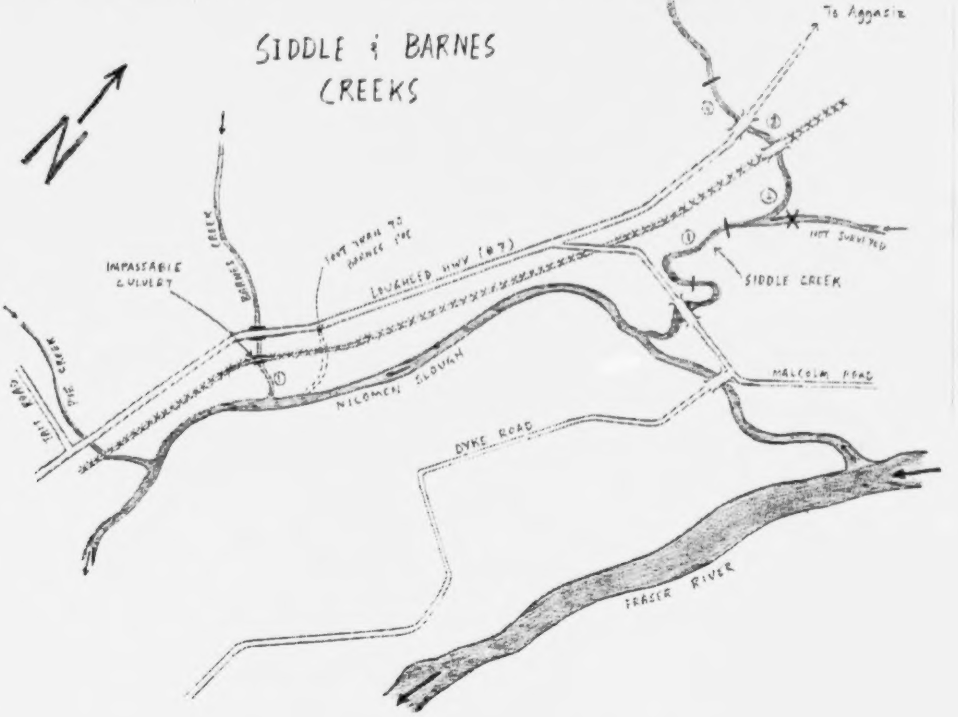
Barnes Creek flows south through undisturbed forested and residential areas for 2.5 km, entering Nicomen Slough east of Deroche. It has one unnamed tributary.

METHODS

Study Area: The creek was surveyed from 2001-2005 (excluding 2003) for coho and chum using consistent segment boundaries. The survey area consists of a single 85 m long segment that runs from the mouth to an impassable culvert at Highway 7.

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Mouth (into Nicomen Slough)	49°11'53" N 122°2'59" W	Marker at impassable culvert	49°11'56" N 122°2'58" W	85	10-15

Segment 1 extends 85 m from the confluence with Nicomen Slough, northwest (upstream) to the impassable culvert. Spawning habitat is abundant, with a substrate of predominantly small loose gravel and cobble. Cover consists of overhanging streamside grasses and instream woody debris. In the upper portion, there is a narrow riparian buffer of mixed deciduous trees and shrubs. The gradient is low and flows are slow even after heavy rainfall.


SIDDLE & BARNES CREEKS
N
To Aggasiz
②
①
②
①
NOT SURVEYED
SIDDLE CREEK
IMPASSABLE CULVERT
BARNES CREEK
FOOT TRAIL TO BARNES CRK
LOUGHEED HWY (#7)
TAIT ROAD
PYE CREEK
①
NICOMEN SLOUGH
MALCOLM ROAD
DYKE ROAD
FRASER RIVER

Barnes Creek (and Siddle Creek) sketch map (not to scale).

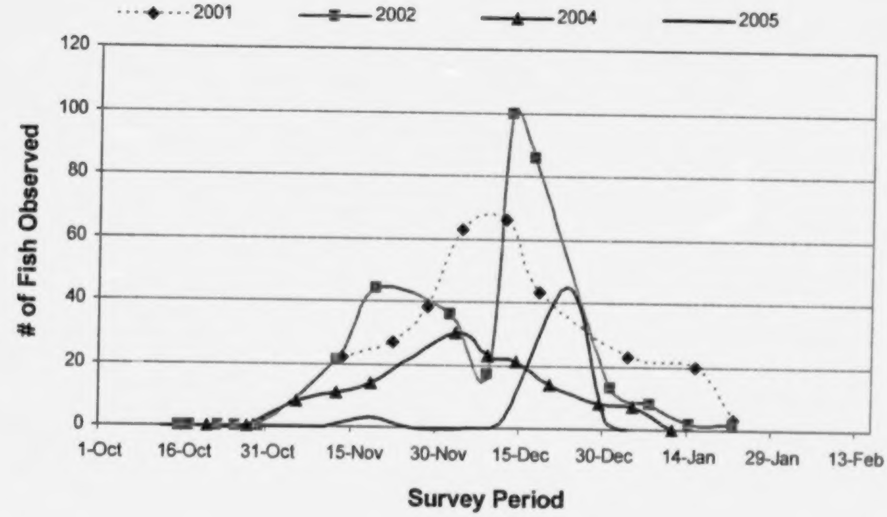
Survey Logistics: One crew member accesses the survey area from a pullout on Highway 7 located 1.3 km east of Deroche. The survey begins at the mouth (south over the railway tracks) and proceeds upstream to the Highway 7 culvert.

Surveyed Spawning Area: All of the known coho and chum spawning areas are included in the survey area.

RESULTS

Observer Efficiency: The average O.E. is relatively high (average ± standard deviation: 0.80 ± 0.03), reflecting the short survey distance and the clear, shallow water. Observer efficiency is limited only by the cutbanks, surface glare and inter-species mixing.

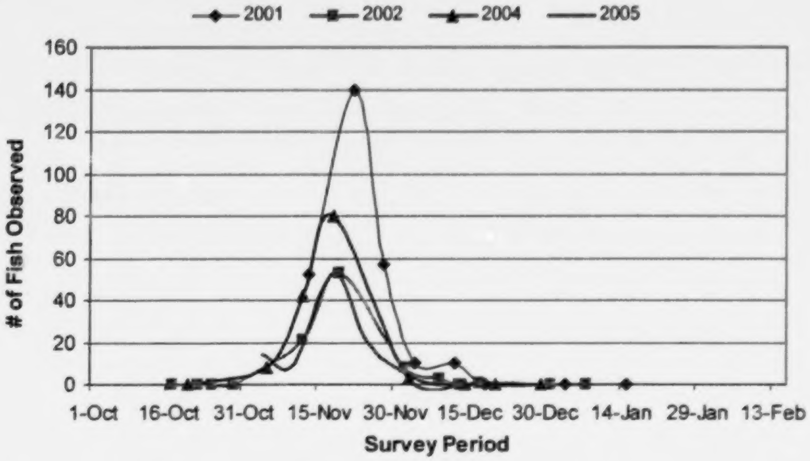
Coho Salmon: Coho run timing was consistent among years, beginning November 5-13, peaking December 3-13 and ending January 19-22. Peak counts ranged from 30-100 coho. In 2001, 2004, and 2005, run timing was unimodal, while the 2002 run timing was bimodal with two distinct spawns associated with rainfall events:



Coho escapements ranged from 42–234 in 2001-2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	269	286	122	52
10	n/a	n/a	242	257	110	47
11	**n/a**	**n/a**	**220**	**234**	**100**	**42**
12	n/a	n/a	202	214	91	39
13	n/a	n/a	186	198	84	36

Chum Salmon: Chum run timing was also consistent among years, beginning November 4-13, peaking November 18-22 and ending December 3-13. Peak counts ranged from 53-140 chum. Run timing was unimodal in all years:



Chum escapements ranged from 67-176 in 2001-2005 (R.T.: 10 days):

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	220	107	152	84
9	n/a	n/a	196	95	135	75
10	**n/a**	**n/a**	**176**	**86**	**121**	**67**
11	n/a	n/a	160	78	110	61
12	n/a	n/a	147	71	101	56

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.053 fish/m^2 (2005) to 0.265 fish/m^2 (2001), with an average of 0.174 fish/m^2 over 4 years. Average chum spawner density ranged from 0.042 fish/m^2 (2001) to 0.262 fish/m^2 (2004), with an average of 0.142 fish/m^2 over 4 years.

Spawning habitat was generally abundant throughout the segment (except in the lower part of the creek). High spawner densities suggest that spawning habitat is limiting production for both species. Comments regarding habitat issues and enhancement are provided below:

	Concern	Comments
Flow/Gradient		
Spawning Substrate		
Instream Cover	X	Limited instream cover in lower sections
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer	X	No buffer in lower sections
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Hatchery supplemented	No	No hatchery coho or chum outplants or strays

BLANEY CREEK

Watershed Code: 100-0267-060-086-000-000-000-000-000-000-000

CREEK DESCRIPTION

Blaney Creek flows south from Loon Lake for 4.8 km, joining Spring Creek and subsequently the North Alouette (north of 224 Street in Maple Ridge), South Alouette, and Pitt Rivers. Its tributaries are McKenzie and Loon Creek. In the upper segment the creek flows through undisturbed forested areas and in the lower segment it flows through rural development and agricultural areas.

METHODS

Study Area: This creek was surveyed in 1999-2004 (excluding 2003) for coho and in 2001-2004 (excluding 2003) for chum. The study area extends from Spring Creek to a set of small, passable falls. In 1999 and 2000, the study area had one segment; in later years, it was divided into two segments using the same upper and lower boundaries. The surveyed segments are as follows:

Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Confluence w/ Spring Creek	49°15'51" N 122°36'41" W	First footbridge	49°16'22" N 122°36'22" W	510	20-30
2	First footbridge	49°16'22" N 122°36'22" W	Marker at falls	49°16'22" N 122°36'16" W	350	15-25

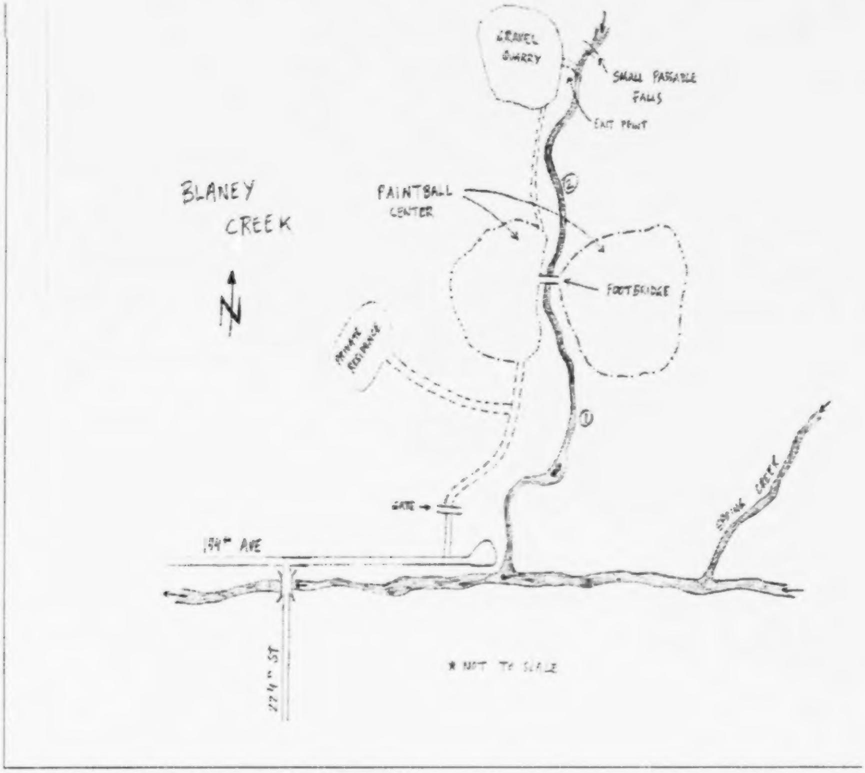
Segment 1 extends 510 m from the mouth to the first foot bridge at the paintball centre (see sketch map). Spawning habitat is abundant, with a substrate of predominantly loose gravel. Cover consists of large woody debris, deep pools, and overhanging streamside vegetation. The gradient is generally low but increases in the upper section where high flows can make surveys difficult. A road to the west is separated from the creek by a narrow mixed-wood forest riparian buffer.

Segment 2 extends 350 m from the foot bridge north to the first set of falls. Spawning habitat is limited (similar to the upstream part of segment 1), with a stream type characterized by large boulders and fast high-gradient riffles. Instream cover is limited to eddies on the downstream side of larger boulders and cutbanks. The riparian buffer on the creek's east side is larger than in segment 1 as the stream diverges east from the road.

Survey Logistics: Two crew members access the survey area by driving north on 224th Street (Maple Ridge), turning right at the Spring Creek bridge crossing onto 144th Avenue and following 144th Avenue to its end and parking at the gate. One crew member surveys segment 1, exits through the paintball centre and returns to the vehicle. The second crew member accesses the creek at the end of segment 1, surveys from there to the falls, exits the creek through the gravel pit to the west and returns to the truck along the access road.

NOTE: In 2004 and 2005 there was a landowner in the house adjacent to the paintball centre (middle of segment 2) that should be contacted prior to each survey. Contact the authors for information on health and safety concerns related to this creek.

Proportion of Spawning Area: The proportion of spawning area covered by the survey, for both coho and chum, is assumed to be very good to excellent as the creek is surveyed from the mouth up to a series of impassable falls.

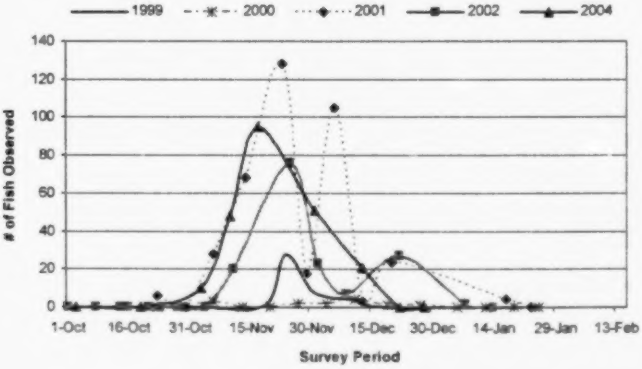

BLANEY CREEK
N
GRAVEL QUARRY
SMALL PASSABLE FALLS
EXIT POINT
②
PAINTBALL CENTER
FOOTBRIDGE
PRIVATE RESIDENCE
①
GATE
SPRING CREEK
194th AVE
224th ST
* NOT TO SCALE

Blaney Creek sketch map (not to scale).

RESULTS

Observer Efficiency: Average O.E. was moderate (0.69 ± 0.13) in all years. Observer efficiency is higher in segment 1 (average: 0.72 ± 0.11) than segment 2 (average: 0.58 ± 0.14), reflecting the lower gradient, slower flows and smaller substrate. It is limited by instream cover (cutbanks, overhanging vegetation, and instream debris) in both segments.

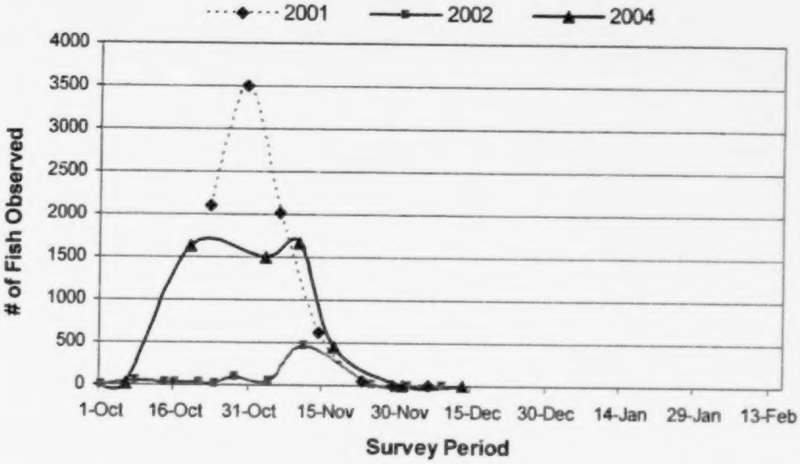
Coho Salmon: Coho run timing varied among years, beginning October 23 to November 19, peaking November 19 to December 22 and ending December 13 to January 17. Peak counts ranged from 28-128 coho. The annual run timing was either unimodal or bimodal:



Coho escapements ranged from 9-211 in 1999-2004 (R.T.: 11 days):

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	31	11	44	183	258	n/a
10	28	10	40	165	232	n/a
11	**25**	**9**	**36**	**150**	**211**	**n/a**
12	23	8	33	137	194	n/a
13	21	8	31	127	179	n/a

Chum Salmon: Chum run timing was consistent among years, beginning October 6-23, peaking October 19 to November 10 and ending November 17 to December 2 (**Note:** 2001 assessment commenced after the start of the run). Peak counts ranged from 462-3,501 chum. Run timing was generally unimodal:



Chum escapements ranged from 675-5,603 (R.T.: 10 days) in 2001-2004:

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	6,582	843	7,004	n/a
9	n/a	n/a	5,851	750	6,226	n/a
10	**n/a**	**n/a**	**5,266**	**675**	**5,603**	**n/a**
11	n/a	n/a	4,787	613	5,094	n/a
12	n/a	n/a	4,388	562	4,669	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.0004 fish/m^2 (2000) to 0.015 fish/m^2 (2004), with an average of 0.006 fish/m^2 over 5 years. Average chum spawner density ranged from 0.037 fish/m^2 (2002) to 0.482 fish/m^2 (2001), with an average of 0.274 fish/m^2 over 3 years. The greatest proportions of spawners (coho: 0.85 and chum: 0.92) were observed in segment 1. During peak spawning, chum redds often overlapped as densities could be very high in segment 1.

Spawning habitat is abundant in segment 1 where the substrate is predominantly small loose gravel and cobble. It is limited in segment 2 where gradient, flow, and substrate size are greater. In both segments, instream cover is abundant and there is a moderate riparian buffer. Potential habitat concerns are related to paintball activities and an adjacent road:

	Concern	Comments
Flow/Gradient	X	Fast flows and high gradient in segment 2.
Spawning Substrate	X	Limited in segment 2 - large boulders.
Instream Cover	X	Limited in segment 2 to eddies below boulders
Adjacent Land Use		
Residential		
Agricultural		
Roads	X	Access road runs along west side of creek.
Riparian Buffer	X	Lack of adequate buffer along west side road.
Stream bank erosion		
Garbage	X	Periodically observed on the creek banks.
Spawning disturbance	X	Paintball games can disturb habitat and spawners.
Beaver activity		
Hatchery supplemented	No	No hatchery coho or chum outplants or strays

CHILQUA CREEK (SLOUGH)

Watershed Code: 100-0585-469-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Chilqua Creek is approximately 2.5 km long (~1.1 km surveyed) and flows west into Chilqua Slough terminating at Hatzic Lake. With no major tributaries, it flows almost entirely through agriculturally-used lands, draining approximately 1.4 km^2 of farmland (Schubert 1982). The creek is low gradient and groundwater fed; water levels are not subject to major fluctuations.

METHODS

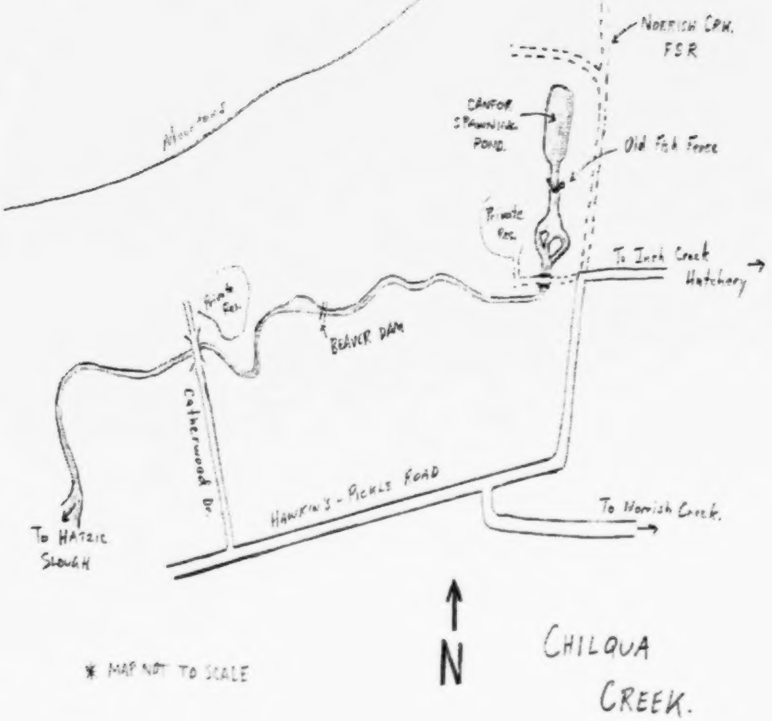
Study Area: The survey area runs from the bridge crossing on Catherwood Drive, east to the end of the Canfor spawning pool adjacent to Norrish Creek Forest Service Road. This creek was surveyed from 2001 to 2004 (excluding 2003) for coho and chum. In 2002, each of the segments were divided in half (total of four survey segments) to further specify spatial distribution in the survey area; the upper and lower boundaries of the survey area did not change. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Catherwood Rd. bridge crossing	49°10'28" N 122°10'51" W	Bell Rd. culvert crossing	49°10'42" N 122°10'3" W	960	45-60
2	Bell Rd. culvert crossing	49°10'42" N 122°10'3" W	end of Canfor spawning pool	49°10'52" N 122°10'0" W	150	10-15

Segment 1 extends 960 m from the bridge crossing at Catherwood Road, east (upstream) to the culvert crossing at Bell Road (see sketch map). Spawning habitat is limited and variable. Benthic substrate in the lower slough-influenced sections of this segment are primarily composed of fines (clay, silts, sand), while the upper sections are mostly loose gravel and cobbles. Instream cover is abundant throughout this segment and includes overhanging streamside vegetation, cutbanks, and instream large woody debris. The gradient is very low and flow remains slow even during moderate rainfall events. Since this segment flows predominantly through agricultural lands, the riparian buffer is extremely limited.

Segment 2 extends 150 m from the Bell Road culvert crossing, northeast (upstream) to the end of the Canfor spawning channel. There is abundant spawning habitat in the upper portions of this segment (spawning pool); benthic substrate changes from sands and silts in the lower sections to spawning gravel in the upper sections. Instream cover is also abundant and includes streamside grasses, cutbanks, and old beaver dams (woody debris). The gradient is extremely low and flow is very slow. There is a wide and dense riparian buffer on either side of the segment composed of mixed forest and tall grasses.

Survey Logistics: Two crew members are required to survey Chilqua Creek. To access the survey area, the crew drive east on Lougheed Highway (towards Mission) to Hawkins-Pickle Road and continue east through the three-way intersection. They follow Hawkins-Pickle Road and turn left (north) onto Catherwood Road. To survey segment 1, one crew member surveys from the bridge crossing at Catherwood Road., east to the culvert crossing on Bell Road. The second crew member drives east on Hawkins-Pickle Road to the culvert at Bell Road and parks the vehicle. To survey segment 2, the second crew member surveys from the culvert to the end of the Canfor spawning pool, exiting north to the forest service road.


Norrish Crk. FSR
Canfor Spawning Pond.
Old Fish Fence
Private Res.
To Inch Creek Hatchery
Private Res.
Beaver Dam
Catherwood Dr.
Hawkin's - Pickle Road
To Norrish Creek.
To Hatzic Slough
* Map not to scale
N
Chilqua Creek.

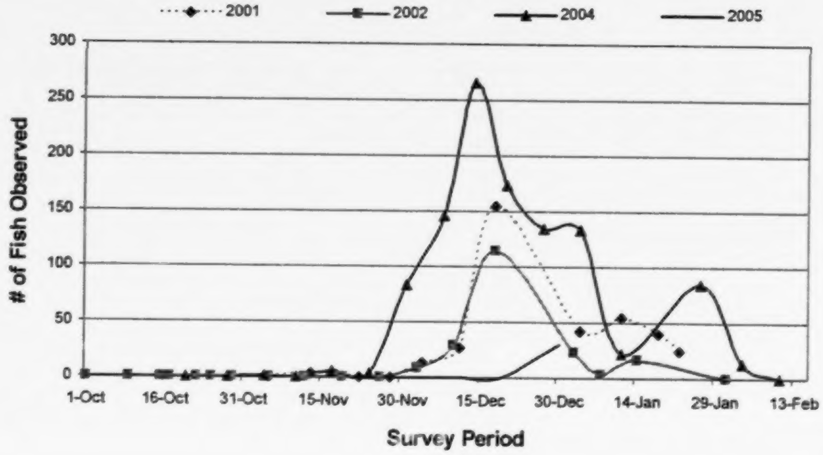
Chilqua Creek sketch map (not to scale).

Proportion of Spawning Area: The proportion of spawning area covered by the survey, for both coho and chum, is assumed to be very good to excellent as the creek is surveyed from very near the confluence with Chilqua Slough, up to a terminal area (Canfor Spawning Pond).

RESULTS

Observer Efficiency: Chilqua Creek had a moderate average O.E. (0.64 ± 0.10) for all years assessed. In Chilqua Creek, O.E. is slightly higher in segment 2 (average: 0.70 ± 0.17) compared to segment 1 (average: 0.58 ± 0.12). Fish observability is reduced in segment 1 by the large amount of fish cover present (primarily deep pools and overhanging streamside vegetation) and increased surface glare due to a small riparian buffer.

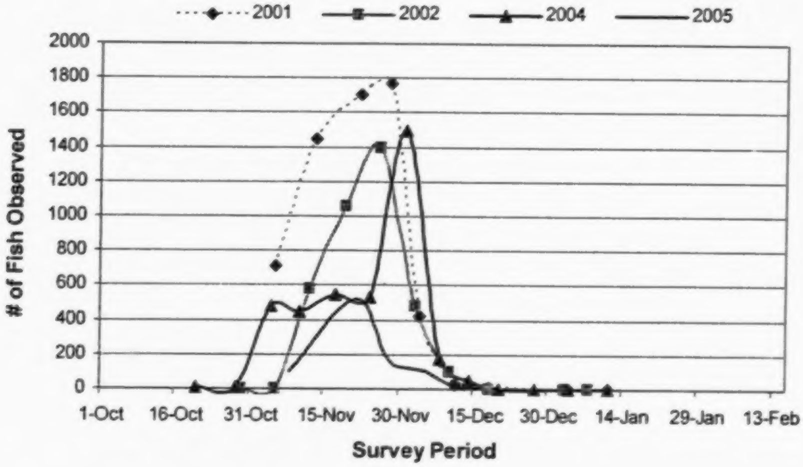
Coho Salmon: Run timing for coho was moderately variable among all years assessed, beginning from November 4 to December 3 and ending between January 14 to February 3. The range for the first peak spawning period was from December 14-18 while the second peak occurred between January 11 to 26. Peak counts ranged from 114-266 coho. Run timing was bimodal with two very distinct peak spawns which occurred over a relatively narrow range:



Coho escapements ranged from 186-689 in 2001 to 2004 (R.T.: 11 days):

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	367	227	842	n/a
10	n/a	n/a	330	204	758	n/a
11	**n/a**	**n/a**	**300**	**186**	**689**	**n/a**
12	n/a	n/a	275	170	631	n/a
13	n/a	n/a	254	157	583	n/a

Chum Salmon: Run timing for chum was consistent among all years assessed, beginning October 20 to November 7, peaking November 26 to December 1 and ending from December 10-20. Peak counts ranged from 1,397-1,769 chum and run timing was unimodal:



Chum escapements ranged from 792-4,150 in 2001 to 2005 (R.T.: 10 days):

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	5,187	3,174	3,192	990
9	n/a	n/a	4,611	2,822	2,837	880
10	**n/a**	**n/a**	**4,150**	**2,539**	**2,553**	**792**
11	n/a	n/a	3,772	2,309	2,321	720
12	n/a	n/a	3,458	2,116	2,128	660

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.001 fish/m^2 (2005) to 0.019 fish/m^2 (2004), with an average of 0.009 fish/m^2 over 4 years. Average chum spawner density ranged from 0.037 fish/m^2 (2005) to 0.181 fish/m^2 (2001), with an average of 0.108 fish/m^2 over 4 years.

Coho and chum spawning was observed from approximately 250 m upstream of the start of segment 1 (no spawning observed below this point). The greatest proportions of both coho (0.91) and chum (0.69) spawners were observed in segment 1.

Spawning habitat is limited to the upper sections of both survey segments; benthic substrate changed from predominantly fines (sands and silts) in the lower sections to small loosened gravel in the upper sections of both segments. The riparian buffer was small in segment 1 (agricultural land) and wide and dense in segment 2 (mixed forest and grass). Both segments had abundant instream cover. Spawning habitat did not appear to be limiting for either species.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	lower sections of segment 1 have heavy siltation; slough-like
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural	X	mid and upper sections of segment 1 flow through agricultural land which was observed to be heavily fertilized with manure and occupied by cattle on both sides; susceptible to agricultural runoff
Roads		
Riparian Buffer	X	segment 1 has a minimal riparian buffer
Stream bank erosion	X	mid and upper sections of segment 1 are susceptible to bank erosion due to heavy agricultural use adjacent to stream
Garbage		
Spawning disturbance		
Beaver activity	X	active beaver community in this watershed; beaver dams occurred both in and downstream of surveyed segments; they may present a barrier to fish migration
Hatchery supplemented	No	No coho or chum stocked

COGHLAN CREEK

Watershed Code: 100-0388-430-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Coghlan Creek is approximately 7.5 km long (5 km surveyed) and flows west into the Salmon River at Williams Park, and ultimately into the south side of the Fraser River. The creek originates in low lying agricultural land and is fed largely by groundwater from the Hopington Aquifer (Nener and Wernick 1997). Summer flows are low and water extraction is responsible for the annual drying of upper Coghlan Creek. The surveyed segments of the creek flow through forested, residential and agricultural areas.

METHODS

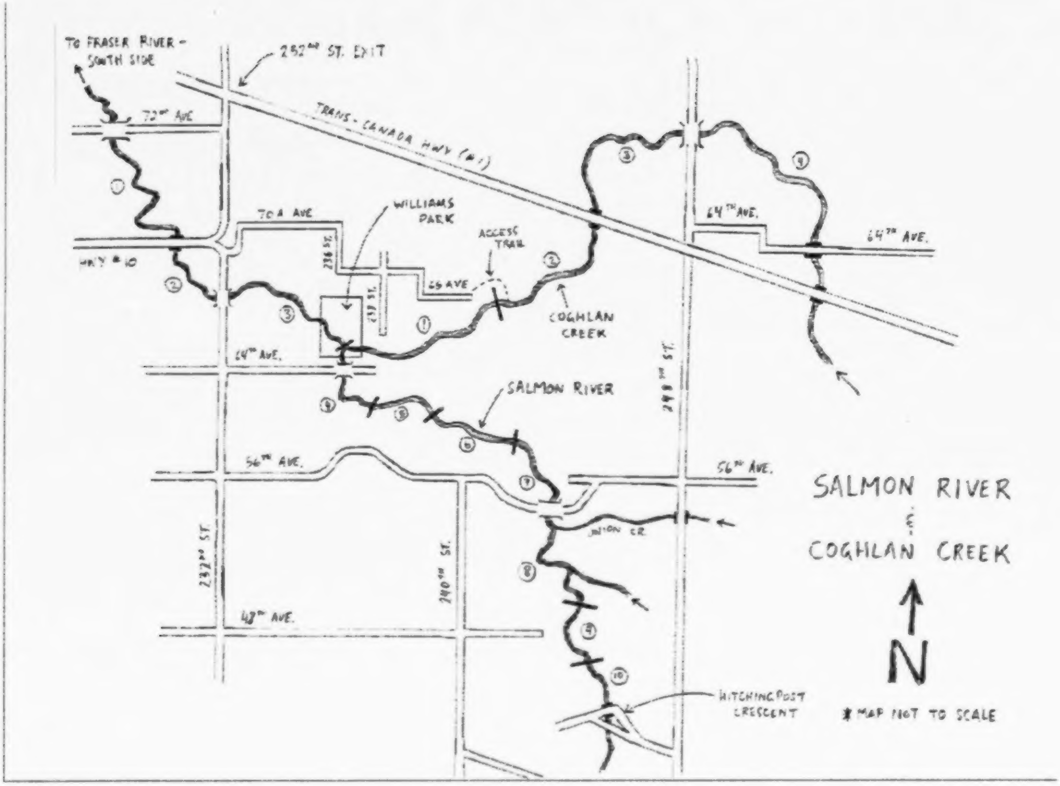
Study Area: This creek was surveyed from 1999 to 2005 (excluding 2003) for coho and from 2001 to 2005 (excluding 2003) for chum. The surveyed area extends from Coghlan Creek's confluence with the Salmon River, east to the 64th Avenue culvert crossing. From 1999 to 2001 the study area had three segments; in later years, it was divided into four segments using the same upper and lower boundaries. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	confluence w/ Salmon R.	49°7'19" N 122°34'8" W	holly tree	49°7'7" N 122°33'17" W	1000	20-30
2	holly tree	49°7'7" N 122°33'17" W	Highway #1 culvert crossing	49°7'21" N 122°32'48" W	1500	30-40
3	Highway #1 culvert crossing	49°7'21" N 122°32'48" W	248 St bridge crossing	49°7'30" N 122°32'13" W	1500	30-40
4	248 St bridge crossing	49°7'30" N 122°32'13" W	64 Ave culvert crossing	49°7'7" N 122°30'37" W	1000	15-25

Segment 1 extends 1 km from Coghlan Creek's confluence with the Salmon River (Williams Park), east (upstream) to the marker at a large holly tree on river right. There is moderate spawning habitat in this segment; benthic substrate is predominantly sands and boulders with intermittent gravel deposits. Instream cover consists of deep pools, dark water, overhanging streamside vegetation, and tight canopy closure. The gradient is gradual and flows are moderate. The riparian buffer is abundant and consists of mixed wood forest. This segment experiences high levels of beaver activity that may restrict fish migration from damming.

Segment 2 extends 1.5 km from the marker at the large holly tree, east (upstream) to the Highway #1 culvert crossing. Spawning habitat is abundant throughout this segment; benthic substrate is small loose gravel. Instream cover is abundant and consists of deep pools, cutbanks, and instream woody debris. The gradient is gradual and flows are moderate. There is a wide and dense riparian buffer of mixed wood forest.

Segment 3 extends 1.5 km from the Highway #1 culvert crossing, northeast (upstream) to the 248th Street bridge crossing. There is abundant spawning habitat in this segment; benthic substrate is gravel interspersed with large boulders and fines. Instream cover is abundant and consists of instream woody debris and deep pools. The gradient is gradual and flows are moderate. In this segment, the riparian buffer varies from residential lands (limited) to mixed deciduous forest (wide and dense).


TO FRASER RIVER - SOUTH SIDE
232ND ST. EXIT
72ND AVE
TRANS - CANADA HWY (#1)
70 A AVE
WILLIAMS PARK
ACCESS TRAIL
HWY # 10
236 ST.
238 ST.
65 AVE
COGHLAN CREEK
64TH AVE.
SALMON RIVER
248TH ST.
56TH AVE.
SALMON RIVER & COGHLAN CREEK
N
JUNION CR.
232ND ST.
240TH ST.
48TH AVE.
HITCHING POST CRESCENT
* MAP NOT TO SCALE
①
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Coghlan Creek (and Salmon River) sketch map (not to scale).

Segment 4 extends 1 km from the 248th Street bridge crossing, southeast (upstream) to the 64th Avenue culvert crossing. There is abundant spawning habitat throughout the entire segment; benthic substrate is small gravel and cobble. There is abundant cover that includes instream woody debris, overhanging vegetation, and deep pools. The gradient is gradual and flows are moderate. Since this segment largely flows through residential developments, the riparian buffer is limited.

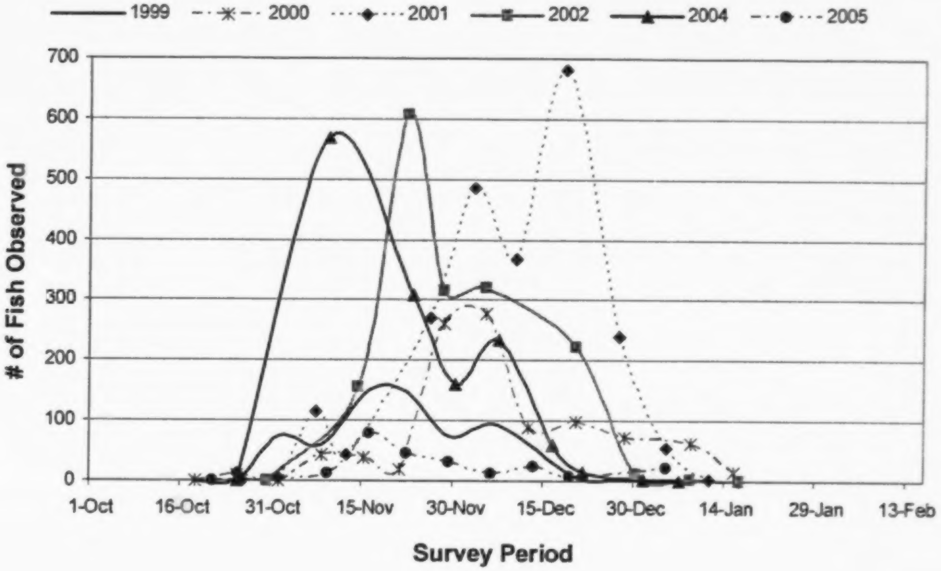
Survey Logistics: Two crew members are required to survey Coghlan Creek. Due to its close proximity with the Salmon River, these two systems are generally surveyed simultaneously. To access the survey area, the crew drives south on 232nd Street and turns left (east) onto 70A Avenue. They follow 70A Ave. through the bends in this road and turn right onto 238th Street until they reach Williams Park where they enter and park their vehicle. The crew follows the stairs down to confluence of Coghlan Creek and Salmon River. To survey, two crew members survey from the confluence upstream to the 64th Avenue culvert crossing where the Salmon River survey crew has parked a vehicle.

Proportion of Spawning Area: There are unsurveyed spawning areas located above the upper segment boundary. The proportion of spawning area covered by the survey is assumed to be good to very good for coho and very good for chum.

RESULTS

Observer Efficiency: Coghlan Creek had a moderate average O.E. (0.66 ± 0.10) for all segments assessed. Observer efficiency was similar among survey segments for all assessment years: segment 1 (average: 0.65 ± 0.10); segment 2 (average: 0.66 ± 0.13) and segment 3 (average: 0.67 ± 0.12). Factors that reduced visibility in Coghlan Creek included poor water clarity (deep pools and increased turbidity during rain events), surface glare (limited riparian buffer), abundant instream cover (cutbanks, woody debris, deep pools, overhanging streamside vegetation), and substrate colouration (limited contrast among substrate and spawning salmon).

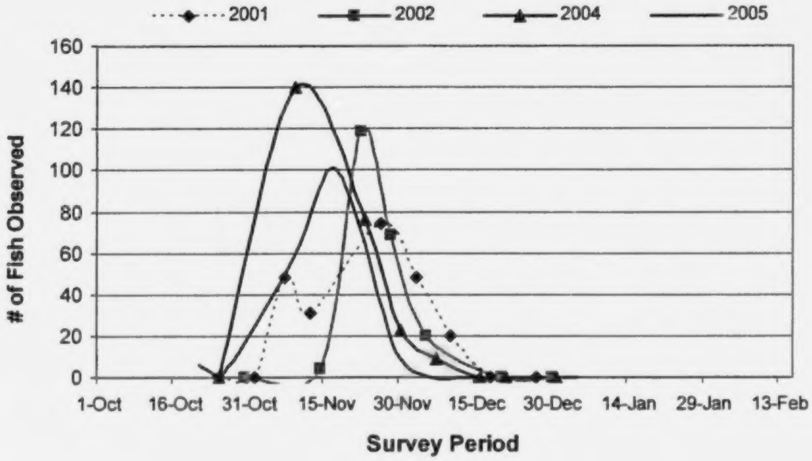
Coho Salmon: Coho run timing varied among years, beginning October 25 to November 14, peaking , November 9 to December 18, and ending December 31 to January 22. Peak counts ranged from 79-682 coho. Run timing was multi-modal (several peak spawning dates), usually coinciding with rain events:



Coho escapements ranged from 347-4,222 coho in 1999-2005; R.T.s used to calculate annual escapements were estimated from the mark-recapture visual survey R.T. calculations from 1999-2004 (see Results section 3.5 Residence Time) and in 2005 when no mark-recapture study was conducted using a five year average R.T. of 5 days:

1999	2000	2001	2002	2004	2005
1,138	2,192	4,222	1,682	3,078	347

Chum Salmon: Run timings for chum were consistent among all years, beginning November 7-14, peaking November 9-26, and ending December 5-10. Peak visual counts ranged from 48-148 fish. Run timing was generally unimodal with one major peak spawn:



Chum escapements ranged from 144-306 in 2001-2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	179	194	383	231
9	n/a	n/a	160	173	340	205
10	**n/a**	**n/a**	**144**	**156**	**306**	**185**
11	n/a	n/a	131	141	278	168
12	n/a	n/a	120	130	255	154

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.003 fish/m^2 (2005) to 0.044 fish/m^2 (2002), with an average of 0.02 fish/m^2 over 6 years. Average chum spawner density ranged from 0.002 fish/m^2 (2001) to 0.01 fish/m^2 (2004), with an average of 0.007 fish/m^2 over 4 years.

Coho spawning densities were evenly distributed throughout the survey area, with little observed competition for available spawning habitat. Chum distribution varied over the survey years, but remained predominant in the lower segments.

Spawning habitat for coho and chum was abundant in segments 2-4; benthic substrate was predominantly small gravel and cobbles. In segment 1, spawning habitat was limited and consisted of intermittent gravel deposits interspersed among the dominant substrate type of fines (sands, silts, clay) and large cobbles and boulders. Segments 1-3 had abundant instream cover and a wide mixed-wood forest riparian buffer. Segment 4 has a limited riparian buffer as this segment flows through residential properties. Other habitat concerns include livestock and pet access to creek. Spawning habitat did not appear to be limiting.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	limited in segment 1 to intermittent gravel deposits interspersed among dominant substrate of fines/cobbles/boulders/clay
Instream Cover		
Adjacent Land Use		
Residential	X	segments 3-4 flow through residential properties
Agricultural		
Roads		
Riparian Buffer	X	limited in segment 4 due to adjacent residential land use
Stream bank erosion		
Garbage		
Spawning disturbance	X	livestock and dogs have been observed in the creek in several locations; unrestricted access
Beaver activity		
Hatchery supplemented	No	no coho or chum stocked

HICKS CREEK (KAMP SLOUGH)

Watershed Code: 100-0916-613-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Hicks Creek is approximately 4.7 km long (~0.3 km surveyed) and flows southwest from Hicks Lake into Maria Slough, northeast from Agassiz. The surveyed area flows primarily through undisturbed forested areas and agricultural lands.

METHODS

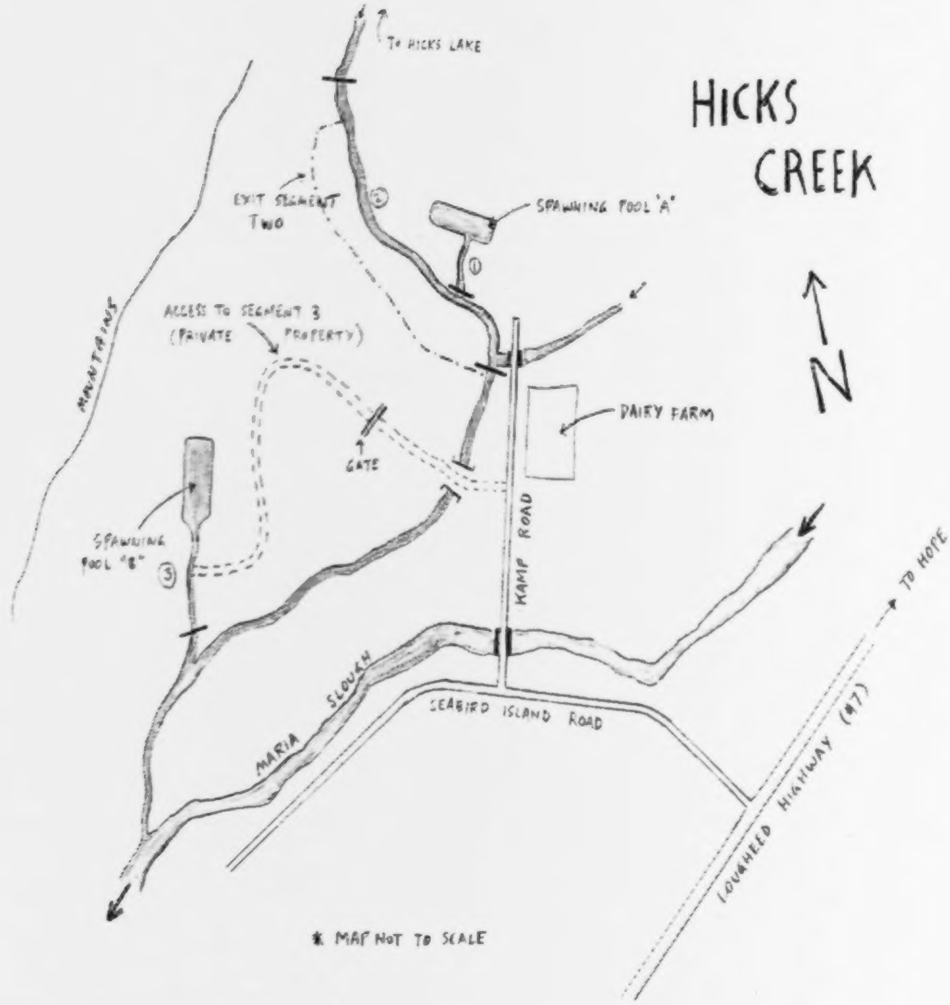
Study Area: This creek was surveyed from 2001 to 2005 (excluding 2003) for coho and chum. In 2004, segment 2 was extended (~50 m) mid-season to incorporate for observed coho spawning distribution. The surveyed area includes two man-made spawning pools and approximately 250 m of creek starting at the Kamp Road culvert crossing to the 200 m marker. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	confluence w/ Hicks Creek	49°18'47" N 121°42'30"	end of spawning pool A	49°18'51" N 121°42'27" W	50	5-10
2	Kamp Rd culvert crossing	49°18'45" N 121°42'26" W	marker	49°18'53" N 121°42'32" W	100	10-15
3	confluence w/ Hicks Creek	49°18'34" N 121°42'23" W	end of spawning pool B	49°18'42" N 121°42'43" W	50	10-15

Segment 1 extends approximately 50 m from the confluence with Hicks Creek mainstem, northeast (upstream) to the end of spawning pool A. In this segment, the creek and the spawning pool are surveyed. Spawning habitat is abundant throughout this segment; benthic substrate is composed largely of loose gravel deposited through enhancement activities. In the creek section of this segment, there is abundant instream cover that includes overhanging streamside vegetation, and instream woody debris. The spawning pool, however, is highly exposed with limited cover comprised of overhanging Himalayan Blackberry (*Rubus discolor*). The gradient is very low and flows are slow in this segment. This segment is exposed to residential development and the small riparian buffer is mixed shrubs.

Segment 2 extends approximately 100 m from the culvert crossing at Kamp Road, northwest (upstream) to the marker. There is limited spawning habitat in this segment; benthic substrate is variable and ranges from large boulders and cobbles to areas of small loose gravel. Instream cover is abundant in this segment, consisting of overhanging vegetation, instream woody debris, and cutbanks. The gradient steepens in the segment and flow can be fast. The small riparian buffer is deciduous trees and shrubs.

Segment 3 extends approximately 50 m from the confluence with Hicks Creek mainstem, northeast (upstream) to the end of spawning pool B. In this segment, the creek section and entire spawning pool are surveyed. Spawning habitat is limited to the spawning pool in this segment; benthic substrate in the creek section is predominantly fines, while the pool substrate is primarily composed of small gravel. The gradient and flow are moderate and there is excellent cover from overhanging grasses and stream bank vegetation. There is no riparian buffer along this segment (segment transects agricultural fields).


TO HICKS LAKE
HICKS CREEK
EXIT SEGMENT TWO
②
SPAWNING POOL 'A'
①
ACCESS TO SEGMENT 3 (PRIVATE PROPERTY)
MOUNTAINS
N
DAIRY FARM
GATE
SPAWNING POOL "B"
③
KAMP ROAD
TO HOPE
MARIA SLOUGH
SEABIRD ISLAND ROAD
LOUGHEED HIGHWAY (#7)
* MAP NOT TO SCALE

Hicks Creek sketch map (not to scale).

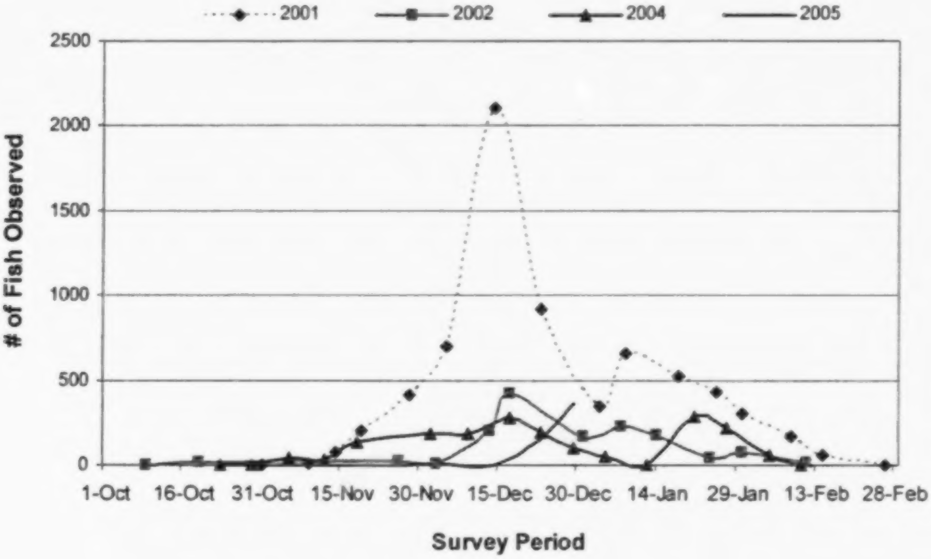
Survey Logistics: Two crew members are required to survey Hicks Creek. To access the survey area, the crew drive east on the Lougheed Highway (#7) and turn left (north) onto Seabird Island Road. They follow Seabird Island Road north and turn right (east) on Kamp Road. They follow Kamp Road east to the Hicks Creek culvert crossing and park the vehicle. To survey segments 1 and 2, both crew members enter at the culvert and survey upstream to the marker. The crew then walk downstream to the start of segment 1 and survey to the end of spawning pool A. To survey segment 3, they follow Hicks Creek downstream to the start of segment 3 and survey from the confluence to the end of spawning pool B and return to the vehicle via Kamp Road.

Proportion of Spawning Area: Although a large proportion of the mainstem is believed to have spawning fish present, only a small section of it can be surveyed. Two man-made spawning pools are assumed to support most of the creek's spawning activity (segments 1 and 3). The coverage of coho spawning area is assumed to be moderate to good. The coverage of chum spawning area is assumed to be good to very good.

RESULTS

Observer Efficiency: Hicks Creek had a high average O.E. (0.79 ± 0.13) for all segments and years assessed and was relatively consistent among segments: segment 1 (average: 0.78 ± 0.11); segment 2 (average: 0.79 ± 0.10); and segment 3 (average: 0.80 ± 0.05). Excellent visibility was attributed to water clarity (clear water), minimal surface glare (dense canopy closure limits the creek's exposure to sunlight), substrate type (high contrast among light colored gravel and dark colored fish) and short survey distances for each segment. Factors that reduced visibility in this creek included instream cover (cutbanks, large woody debris and riffle pools) and, in segment 2, dark substrate (low contrast among substrate and fish).

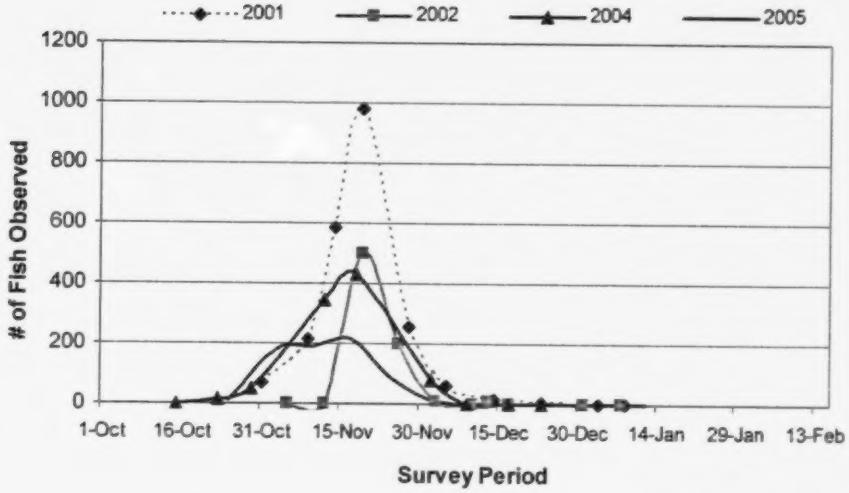
Coho Salmon: Run timing for coho was moderately variable among years, beginning October 31 to November 19 and ending February 3-26. Peak counts ranged from 290-2,105 coho. Run timing was bimodal with two peak spawning periods; the first peak in the run ranged from December 14-17 while the second peak ranged from January 7-21:



Coho escapements ranged from 566-5,224 in 2001-2005 (R.T.: 11 days):

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	6,385	1,213	1,541	692
10	n/a	n/a	5,747	1,092	1,387	622
11	**n/a**	**n/a**	**5,224**	**993**	**1,261**	**566**
12	n/a	n/a	4,789	910	1,156	519
13	n/a	n/a	4,420	840	1,067	479

Chum Salmon: Run timing for chum was generally consistent among years, beginning October 31 to November 19, peaking November 18-19, and ending December 2-23. Peak counts ranged from 214-982 chum. Run timing was distinctly unimodal with one major peak spawn:



Chum escapements ranged from 500-1,432 in 2001-2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	1,790	624	1,158	654
9	n/a	n/a	1,591	555	1,030	581
10	**n/a**	**n/a**	**1,432**	**500**	**927**	**523**
11	n/a	n/a	1,302	454	842	475
12	n/a	n/a	1,193	416	772	436

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.123 fish/m^2 (2005) to 0.606 fish/m^2 (2001), with an average of 0.265 fish/m^2 over 4 years. Average chum spawner density ranged from 0.126 fish/m^2 (2005) to 0.639 fish/m^2 (2001), with an average of 0.35 fish/m^2 over 4 years.

Coho and chum were observed spawning in all three segments. The greatest proportions of fish were observed in segments 2 (average: coho 0.40, chum 0.35) and 3 (average: coho 0.35, chum 0.40). There was no competition for space in segments 2 and 3 with a small amount of spatial overlap of spawners in spawning pool A (segment 1).

Spawning habitat was abundant in segment 1 and segment 3's spawning pools. Spawning habitat was limited in segment 2 where benthic substrate was predominantly large cobbles. Instream cover was only abundant in segment 2; segments one and three were highly exposed. Riparian buffers were extremely limited in all three segments by the presence of adjacent residential properties.

	Concern	Comments
Flow/Gradient	X	low water conditions observed in spawning pools in the summer months resulting in stranding of juvenile salmonids
Spawning Substrate	X	limited in segment 2 (boulders and cobbles); limited in segment 3 to the spawning pool only
Instream Cover		
Adjacent Land Use		
Residential	X	occurs adjacent to segment 1
Agricultural	X	occurs adjacent to segment 3
Roads		
Riparian Buffer	X	limited buffer segment 1 due to residential development; non-existent in segment 3 due to agricultural land use
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Hatchery supplemented	No	no coho or chum stocked

HOPEDALE SLOUGH (CREEK)

Watershed Code: 100-0657-097-074-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Hopedale Slough is approximately 2.3 km long and flows parallel to the Chilliwack River to its confluence with Street Creek near the B.C. Hydro rail bridge (~2 km northeast of the city of Yarrow). The slough is groundwater fed and the surveyed segment flows through undisturbed forested areas. The slough has been enhanced through the addition of spawning gravel (DFO habitat enhancement project, 1990).

METHODS

Study Area: This creek was surveyed from 1999 to 2005 (excluding 2003) for coho and from 2001 to 2005 (excluding 2003) for chum. In 2002, segment 1 was divided into two survey segments; all other years' segment distances and boundaries were identical. The survey area extends from the footbridge opposite Bergman Road, east (upstream) to the end of the spawning pool (groundwater entrance). The surveyed segments are as follows:

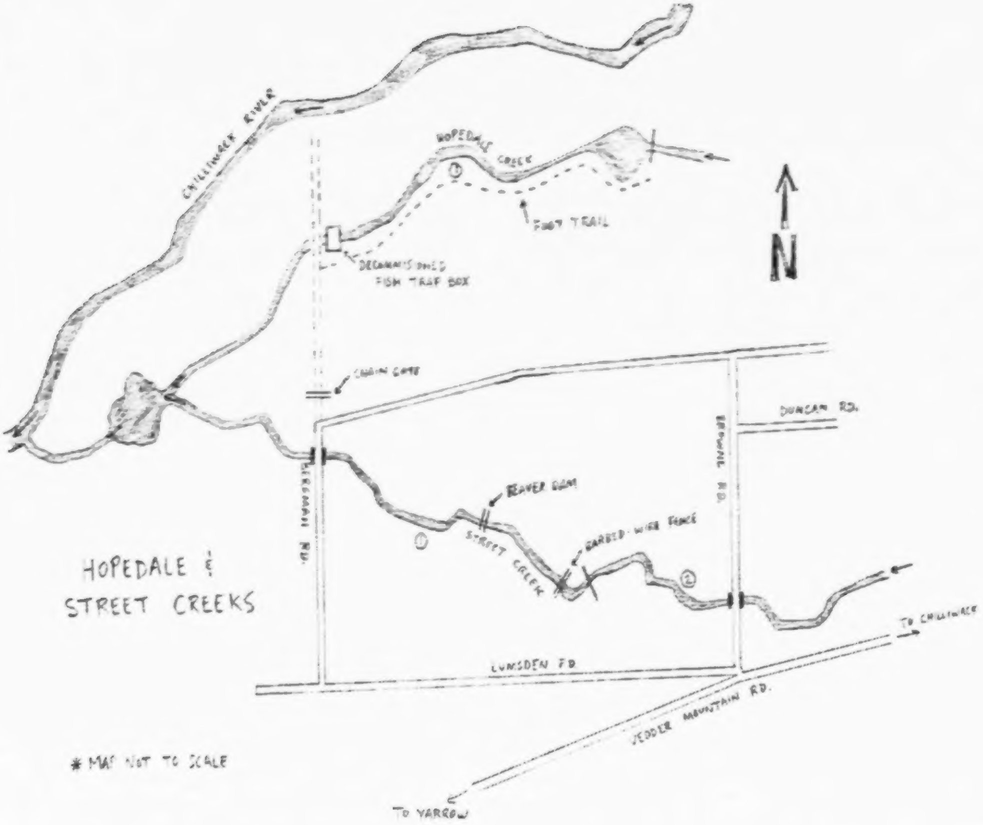
Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Footbridge opposite Bergman Rd.	49o5'45" N 122o1'45" W	Marker	49o5'48" N 122o1'22" W	500	15-20
2	Marker	49o5'48" N 122o1'22" W	End of Slough (spawning pool)	49o5'52" N 122o1'10" W	460	15-20

Segment 1 extends 500 m from the footbridge opposite Bergman Road, east (upstream) to the marker. Spawning habitat in this segment is limited; substrate is predominately silt with small interspersed patches of gravel. Instream cover for salmon is abundant and consists of overhanging vegetation, a few undercut banks, and considerable amounts of aquatic vegetation. Gradient is low and water levels are deep. There is no riparian buffer along the south side of the slough, due to a large path that runs parallel to this segment, while the north bank has a dense riparian buffer of mixed trees and shrubs.

Segment 2 extends 460 m from the marker, east (upstream) to the end of the slough (spawning pool). Spawning habitat is abundant; benthic substrate consists of predominately small gravel and cobble. Instream cover is minimal, consisting of overhanging and instream vegetation. There is no riparian buffer along the south side of the slough, due to a large path that runs parallel to this segment, while the north bank has a dense riparian buffer of mixed trees and shrubs.

Survey Logistics: One crew member is required to survey Hopedale Slough. To access the survey area, the crew drive west on Vedder Mountain Road (Chilliwack) and turn right (east) on Lumsden Road. They follow Lumsden Road west and turn right onto Bergman Road and park the vehicle at the chain gate at the end of Bergman Road. To survey segment 1, one crew member follows the path north towards the Chilliwack River to the footbridge. They enter the slough at the footbridge and walk to the end of slough. They exit the creek and return to the vehicle using the path on the left side of the slough. This path may also be used by the surveyor to bypass deep pools encountered during the survey.

Proportion of Spawning Area: Although there is no barrier at the end of the survey area, few fish have been observed utilizing areas above the spawning pool. There is also a small unsurveyed section below the survey area. The coverage of spawning area for both coho and chum is assumed to be good to very good.

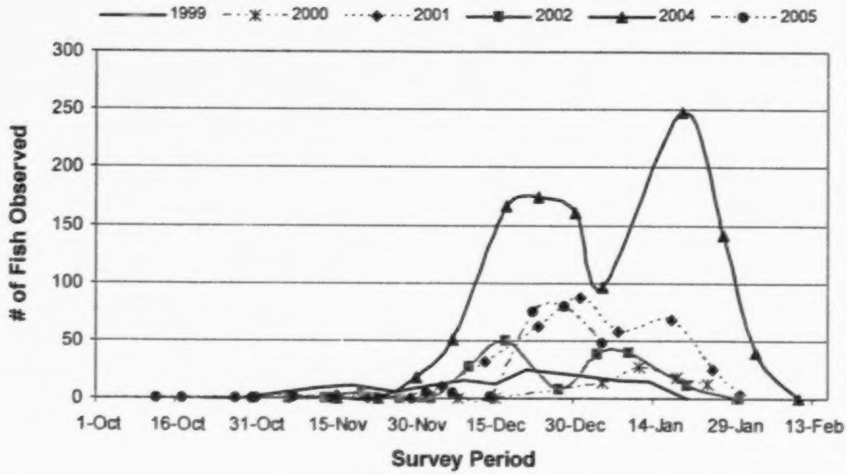

CHILLIWACK RIVER
HOPEDALE CREEK
①
FOOT TRAIL
N
DECOMMISSIONED FISH TRAP BOX
CHAIN GATE
DUNCAN RD.
BROWNE RD.
LICKMAN RD.
BEAVER DAM
①
STREET CREEK
BARBED-WIRE FENCE
②
HOPEDALE & STREET CREEKS
TO CHILLIWACK
LUMSDEN RD
VEDDER MOUNTAIN RD.
* MAP NOT TO SCALE
TO YARROW

Hopedale Slough (and Street Creek) sketch map (not to scale).

RESULTS

Observer Efficiency: Hopedale Slough had a moderate average O.E. (0.69 ± 0.11) for all years assessed. Greater than average visibility in this creek can be attributed to excellent water clarity (clear water), minor surface glare (minimal exposure to sunlight), and limited instream cover. Visibility in this creek was reduced by interspecies mixing, instream cover (dense aquatic vegetation), and large concentrations of fish in pools (multi-species stacking).

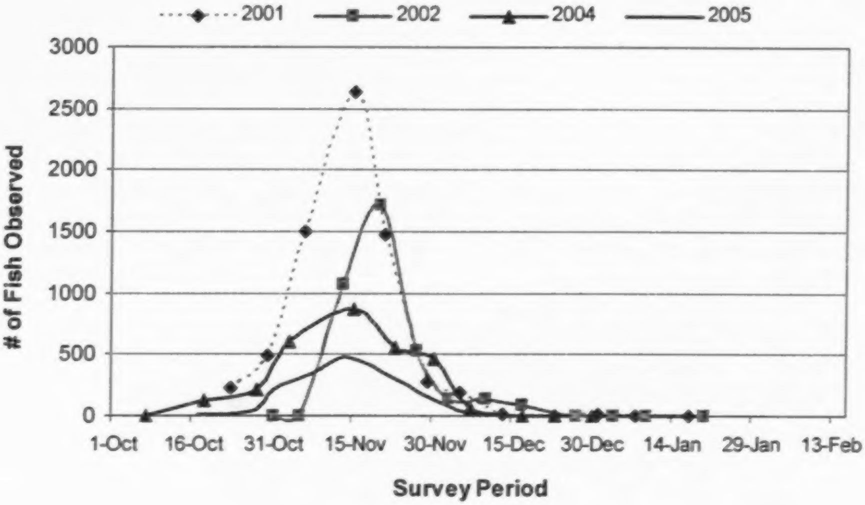
Coho Salmon: Run timing for coho was variable among years, beginning November 4 to December 4, and ending from January 13 to February 3. Escapement curves are generally bimodal with two peak spawns. The dates for the initial peak spawn ranged from December 17-31 and while the second peak spawn ranged from January 9 to 19. Peak visual counts ranged from 25-248 coho:



Coho escapements ranged from 59-762 in 1999 to 2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	115	73	317	160	931	221
10	104	65	285	144	838	199
11	**94**	**59**	**259**	**131**	**762**	**181**
12	86	54	238	120	698	166
13	80	50	219	111	644	153

Chum Salmon: Run timing for chum was moderately consistent among years, beginning October 14 to November 13, peaking November 15-20 and ending December 15-31. Peak counts ranged from 485-2,630 chum. Run timing was generally unimodal with one peak spawn:



Chum escapements ranged from 1,139-4,978 in 2001-2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	6,223	3,269	3,120	1,423
9	n/a	n/a	5,532	2,906	2,774	1,265
10	**n/a**	**n/a**	**4,978**	**2,616**	**2,496**	**1,139**
11	n/a	n/a	4,526	2,378	2,269	1,035
12	n/a	n/a	4,149	2,180	2,080	949

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.003 fish/m^2 (2005) to 0.03 fish/m^2 (2004), with an average of 0.009 fish/m^2 over 6 years. Average chum spawner density ranged from 0.025 fish/m^2 (2005) to 0.17 fish/m^2 (2001), with an average of 0.103 fish/m^2 over 4 years. The highest coho densities were observed where chum densities were the lowest.

Spawning habitat was abundant throughout the entire survey area. There was abundant spawning substrate, instream cover, and a moderate riparian buffer. Spawning habitat appeared to be limiting particularly during peak chum spawning when overlapping redds were observed. Spawning densities for chum may have been limited in the lower sections of the survey area due to higher density of aquatic vegetation.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	spawning substrate is limited by the extremely dense aquatic vegetation growth in the creek
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer	X	no riparian buffer on the south side of the slough due to the presence of a path
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity	X	intermittent beaver activity in segment 2
Hatchery supplemented	No	not stocked for coho or chum; although not observed, straying might occurred from stocked chum or coho in the Chilliwack River

KANAKA CREEK

Watershed Code: 100-0374-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Kanaka Creek is approximately 19 km long (~2.4 km surveyed) and flows south into the north side of the Fraser River, northwest of McMillian Island. Some of the creek's major tributaries include Spencer, Salamander, Seigie, and Rainbow creeks. The upper sections of Kanaka Creek flow across a moderately sloping plateau, entering a canyon at 7.6 km and emerging at 5.7 km. Subsequently the creek flows in a meandering channel across a low-lying plain, becoming slough-like in the lower 3.3 km (Schubert 1982). The lower portions of the creek flows through Kanaka Creek Regional Park, where the Bell-Irving hatchery and counting fence are located.

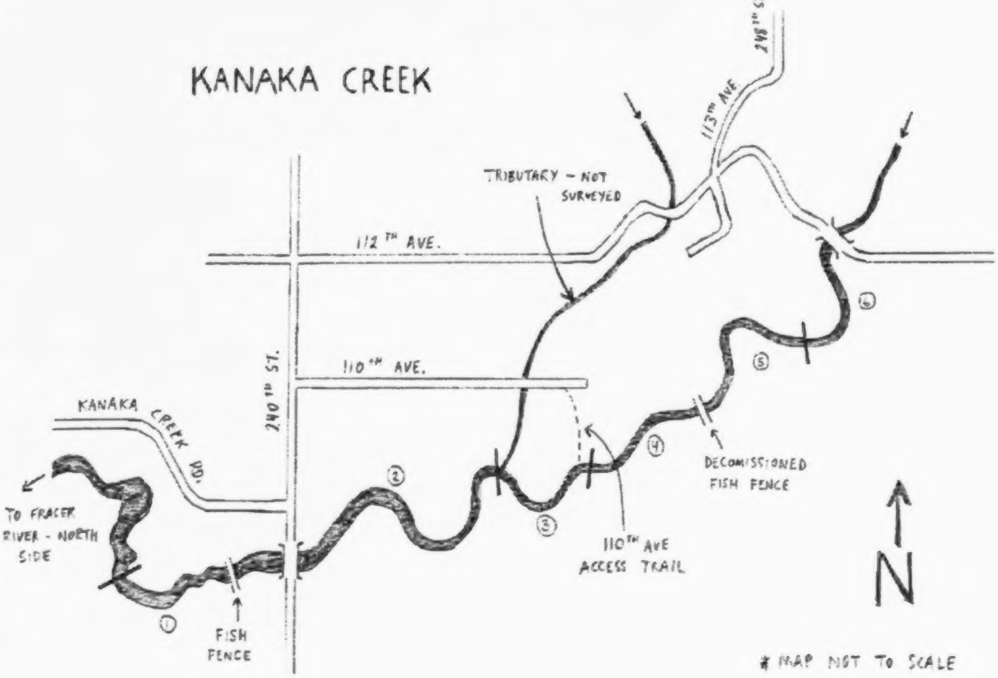
METHODS

Study Area: This creek was surveyed for coho and chum from 2001 to 2005 (excluding 2003). There were two survey segments in 2001 (surveys commenced well into peak chum spawn); this was further divided into six survey segments in 2002, which was mirrored in 2004. Upper and lower survey boundaries were identical for all three survey years. The surveyed area extends from the marker located 200 m downstream of the fish fence, east (upstream) to the 112th Avenue bridge crossing. The surveyed segments are as follows:

Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Access pt. in park, d/s 2 bends to marker	49°11'55" N 122°33'40" W	fish fence	49°11'56" N 122°33'25" W	300	10-15
2	fish fence	49°11'56" N 122°33'25" W	fork in creek	49°12'1" N 122°32'45" W	650	15-20
3	fork in creek	49°12'1" N 122°32'45" W	110 Ave access trail	49°12'7" N 122°32'30" W	350	10-15
4	110 Ave access trail	49°12'7" N 122°32'30" W	Decommisioned fish fence	49°12'13" N 122°32'25" W	500	15-20
5	Decommisioned fish fence	49°12'13" N 122°32'25" W	Giant old stump	49°12'18" N 122°32'6" W	450	10-15
6	Giant old stump	49°12'18" N 122°32'6" W	112 Ave bridge crossing	49°12'26" N 122°32'11" W	200	10-15

Segments 1 and 2 extend 1000 m from the marker located approximately 200 m downstream of the fish fence, east (upstream) to the fork in the creek. In these segments, spawning habitat is limited; benthic substrate is predominantly fines with interspersed clusters of boulders. There is abundant cover from deep pools, dark water, and instream woody debris. The gradient of these segments is very low and flows can be slow and slough-like. There is a minimal riparian buffer of mixed deciduous forest.

Segment 3 extends 350 m from the fork in the creek, east (upstream) to the access trail at 110th Avenue. Spawning habitat is abundant in this segment; benthic substrate is predominantly loose gravel deposits interspersed with larger cobble, with the exception of pools that are sandy. There is limited instream cover from deep pools, dark water, and large woody debris. The gradient of this segment is very low and flows are moderate with riffles. Since this segment flows through a rurally developed residential area, there is a small riparian buffer of mixed deciduous forest.


KANAKA CREEK
248TH ST.
113TH AVE.
TRIBUTARY - NOT SURVEYED
112TH AVE.
110TH AVE.
240TH ST.
KANAKA CREEK RD.
TO FRASER RIVER - NORTH SIDE
①
FISH FENCE
②
③
110TH AVE ACCESS TRAIL
④
DECOMMISSIONED FISH FENCE
⑤
⑥
N
* MAP NOT TO SCALE

Kanaka Creek sketch map (not to scale).

Segment 4 extends 500 m from the access trail at 110th Avenue, east (upstream) to an old decommissioned fish fence. Spawning habitat is abundant in this segment; benthic substrate is predominantly loose gravel deposits interspersed with larger cobble. Mid-segment there is a side channel on river right that is present only during high water flows in the mainstem. This side channel consists of larger boulders and some bedrock. Instream cover is abundant and includes deep pools, dark water, and large woody debris. The gradient of this segment is low and flows are moderate with riffles. The small riparian buffer is mixed deciduous forest.

Segment 5 extends 450 m from the old decommissioned fish fence, east (upstream) to the marker at a large old Western Red Cedar (*Thuja plicata*) stump. Spawning habitat is abundant in the lower section of this segment and is extremely limited in the upper sections; benthic substrate is predominantly loose gravel interspersed with larger cobble, except in pools which have sand/bedrock substrates. Mid-segment, the stream runs through a deep ravine with steep banks. Instream cover is limited to deep pools and dark water. The gradient of this segment is very low and flows are moderate with riffles. There is a minimal riparian buffer of mixed deciduous forest.

Segment 6 extends 200 m from the giant old stump, northeast (upstream) to the 112th Avenue bridge crossing. Spawning habitat is limited in this segment; benthic substrate is predominantly large boulders with small areas of cobble. Instream cover is limited to deep pools and dark water. The gradient of this segment is gradual and flows are moderate with riffles. There is a minimal riparian buffer of mixed deciduous forest.

Survey Logistics: A minimum of four crew members (two vehicles) are required to survey Kanaka Creek. To access the survey area, the crew drive east on the Lougheed Highway (towards Mission) and turn left (north) onto 240th Street. They follow 240th Street north and turn left (west) on Kanaka Creek Road where two crew members park their vehicle at the gate. To survey segments 1-3, the crew follows the access trail (in the park) to a marker (two bends downstream of fish fence) and survey from there to the 110th Avenue access trail marker where the second crew have parked their vehicle. To survey segments 4-6 the second crew park their vehicle at the 110th Avenue trail access and survey from the marker to the 112th Avenue bridge crossing. The first crew picks up the second crew and return to the other vehicle.

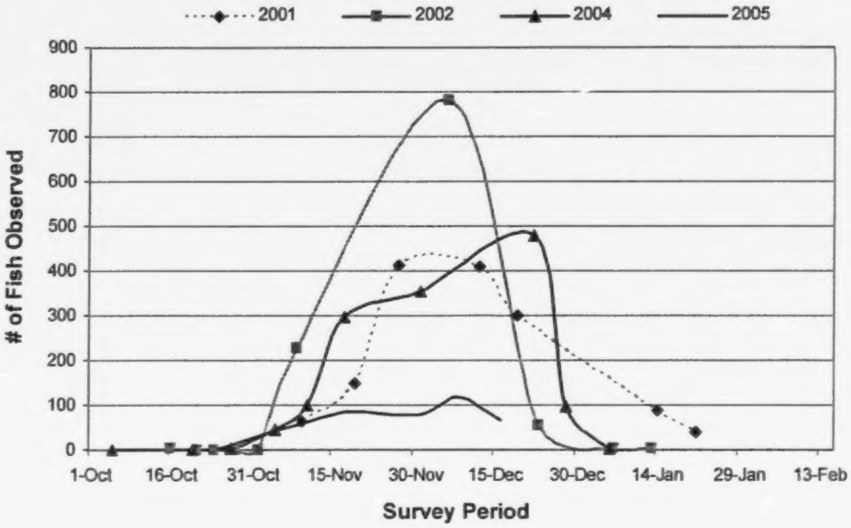
Proportion of Spawning Area: A small proportion of coho spawning area is located above the survey area and a small section of chum spawning area is located below the survey area. The proportion of spawning area covered by the survey, for both coho and chum, is assumed to be very good to excellent.

RESULTS

Observer Efficiency: Kanaka Creek had low average O.E. (0.57 ± 0.02) for all segments and years assessed. The lowest O.E.s were reported for segments 1 (average: 0.37 ± 0.20) and 2 (average: 0.41 ± 0.19). Visibility in these segments was reduced by poor water clarity (light brown color, increased turbidity from upstream spawning activity), and surface glare (limited riparian buffer resulting in the high exposure to sunlight). The upper portions of segment 2 transition between segment 1 habitat characteristics (lower O.E.) and segment 3 habitat characteristics (higher O.E.).

The highest O.E.s were reported for segments 3 (average: 0.64 ± 0.15), 4 (average: 0.69 ± 0.14), 5 (average: 0.66 ± 0.17), and 6 (average: 0.65 ± 0.16) (Figure 38). Visibility was similar in all four segments and was limited by surface glare (moderate exposure to sunlight), and instream cover (downstream pools created by riffles). Segments 3 and 4, with slightly higher O.E. than segments 5 and 6, had shallower and clearer water conditions. Visibility in segment 5 was enhanced by decreased surface glare (segment flows through tight canyon) and increased contrast among fish and substrate type (bedrock and sands). Visibility in segment 6 was reduced by a larger channel width and turbulent water conditions (large riffles).

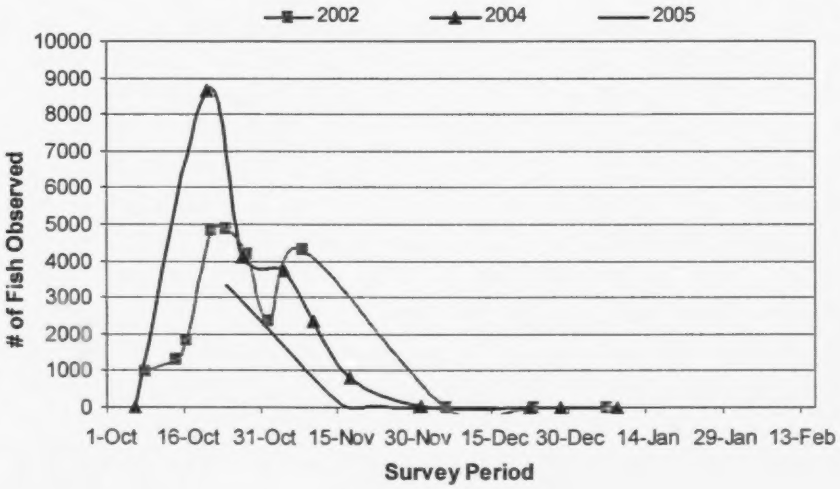
Coho Salmon: Run timing for coho was consistent among years, beginning October 16 to November 19, peaking November 27 to December 22, and ending from January 5-21. Peak counts ranged from 119-781 coho. Run timing was generally unimodal:



Coho escapements ranged from 364-2,042 in 2001-2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	1,544	2,496	1,963	445
10	n/a	n/a	1,389	2,247	1,767	401
11	**n/a**	**n/a**	**1,263**	**2,042**	**1,606**	**364**
12	n/a	n/a	1,158	1,872	1,472	334
13	n/a	n/a	1,069	1,728	1,359	308

Chum Salmon: Run timing for chum was consistent among years, beginning October 5-8, peaking October 20 to November 8, and ending November 8 to December 1. Peak counts ranged from 3,343-8,642 chum. Run timing was both unimodal and bimodal with two distinct spawns in 2002:



Chum escapements ranged from 3,896-17,310 in 2002-2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	n/a	19,538	21,637	4,870
9	n/a	n/a	n/a	17,367	19,233	4,328
10	**n/a**	**n/a**	**n/a**	**15,630**	**17,310**	**3,896**
11	n/a	n/a	n/a	14,209	15,736	3,541
12	n/a	n/a	n/a	13,025	14,425	3,246

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.003 fish/m^2 (2005) to 0.071 fish/m^2 (2001), with an average of 0.024 fish/m^2 over 4 years. Average chum spawner density ranged from 0.051 fish/m^2 (2005) to 0.104 fish/m^2 (2002), with an average of 0.083 fish/m^2 over 3 years.

The greatest proportion of spawning coho was observed in segments 3 (average: 0.25) and 4 (average: 0.34). Coho spawning densities were greatest in segments 3 (average: 0.075 fish/m^2), four (average: 0.015 fish/m^2), and five (average: 0.014 fish/m^2). Densities of coho were relatively low in segment 1 (0.012 fish/m^2) and segment 2 (0.004 fish/m^2) where spawning substrate was limited.

The greatest proportion of spawning chum was observed in segment 3 (average: 0.3), segment 2 (average: 0.22) and 4 (average: 0.21). On average, chum densities were greatest in segments 3 (0.110 fish/m^2) and 4 (0.130 fish/m^2).

Spawning habitat (spawning substrate and instream cover) was abundant in segments 3 to 6. In segments 1 and 2, spawning habitat was limited since benthic substrate was predominantly sand and silt. In all segments, the riparian buffer was comprised of a small mixed-wood deciduous forest. Overall, there are no habitat concerns in this creek.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	limited in segments 1 and 2 (predominantly fines and boulders)
Instream Cover		
Adjacent Land Use		
Residential	X	occurs in segment 3
Agricultural		
Roads		
Riparian Buffer	X	limited in segments 1 and 2; limited in segment 3 due to adjacent residential properties
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Hatchery supplemented	Yes	coho and chum juveniles are stocked by the Bell-Irving Hatchery

Number, average weight and stage at release of coho and chum juveniles stocked into Kanaka Creek from 1999 to 2005.

Species	Release Year	# Released	Avg. Weight (g)	Stage Released
COHO	1999	92,700	15	Smolts
		27,000	2	Fed Spring
	2000	9,145	1	Fed Spring
	2001	72,300	19.2	Smolts
		32,900	7.23	Fed Fall
		54,000	1.2	Fed Spring
	2002	110,000	19	Smolts
		82,000	1.1	Fed Spring
	2003	70,500	17	Smolts
		48,000	1.3	Fed Spring
	2004	50,000	17	Smolts
		19,500	1	Fed Spring
	2005	40,300	18	Smolts
CHUM	1999	154,304	0.6	Fed FW
	2000	115,950	0.6	Fed FW
	2001	159,000	1	Fed FW
	2002	159,000	0.6	Fed FW
	2003	100,000	0.55	Fed FW
	2004	71,500	0.6	Fed FW
	2005	79,728	0.55	Fed FW

KAWKAWA (SUCKER) CREEK

Watershed Code: 100-1154-031-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Kawkawa Creek is approximately 1.3 km long (~0.9 km surveyed) and flows west from Kawkawa Lake to the Coquihalla River and ultimately into the south side of the Fraser River (near Hope). The Kawkawa Creek system, including the lake and its five tributaries, drain a watershed of approximately 9 km^2 (Schubert 1982). Kawkawa Creek mainstem flows through a largely undisturbed forested area, while its tributaries above the lake flow almost entirely through residential areas.

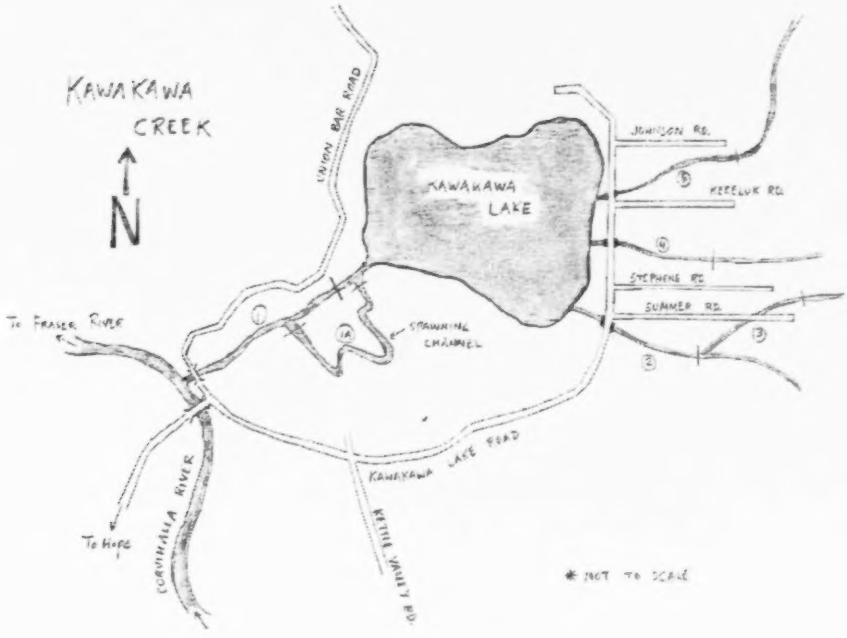
METHODS

Study Area: This creek was surveyed from 1999 to 2004 (excluding 2003) for coho and from 2001 to 2004 (excluding 2003) for chum. Segment 1A was added for 2002 and 2004 surveys; this segment is an artificial spawning channel attached to segment 1. Upper and lower survey boundaries were identical for all five survey years. The surveyed area extends from the creeks' confluence with the Coquihalla River, east to Kawkawa Lake, and from the east side of Kawkawa Lake to the upper markers of four tributaries which drain into the lake. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	mouth (into Coquihalla River)	49°22'58" N 121°25'28" W	dam just below Kawakawa Lake	49°23'8" N 121°24'29" W	315	15-20
1A	spawning channel start	49°23'1" N 121°25'20" W	spawning channel end	49°23'8" N 121°24'29" W	220	15-20
2	culvert on Kawakawa Lake Rd. south of Summer Rd.	49°23'1" N 121°23'33" W	marker	49°22'59" N 121°23'24" W	100	5-15
3	split in channel	49°22'59" N 121°23'24" W	Summer Rd culvert crossing	49°23'3" N 121°23'14" W	145	5-15
4	culvert on Kawakawa Lake Rd. north of Stephens Rd	49°23'8" N 121°23'33" W	marker	49°23'8" N 121°23'24" W	90	5-10
5	culvert on Kawakawa Lake Rd.just north of Kereluk Rd.	49°23'13" N 121°23'32" W	marker	49°23'17" N 121°23'23" W	110	5-15

Segment 1 extends 315 m from Kawkawa Creek's confluence with the Coquihalla River, northeast (upstream) to the dam just below Kawkawa Lake. Spawning habitat is limited to the lower 200 m of this segment; benthic substrate is predominantly large cobbles and boulders interspersed with small areas of gravel. Instream cover is limited to overhanging streamside vegetation. The gradient steadily increases and flow can be swift. There is a small riparian buffer of deciduous forest and small shrubs on either bank.

Segment 1A is 220 m long and runs parallel to Kawkawa Creek mainstem. This segment is a man-made spawning channel containing abundant spawning habitat; benthic substrate consists of loose gravel and cobble. Instream cover is abundant, including cutbanks and overhanging streamside vegetation. The gradient is low and flow remains moderate even during periods of heavy rainfall. There is a limited riparian buffer of streamside vegetation paralleling the entire segment.


KAWAKAWA CREEK
N
UNION BAR ROAD
KAWAKAWA LAKE
JOHNSON RD.
KEELUK RD.
STEPHENS RD.
SUMMER RD.
5
4
3
2
1
1A
SPAWNING CHANNEL
To FRASER RIVER
To Hope
COQUIHALLA RIVER
KAWAKAWA LAKE ROAD
KETTLE VALLEY RD.
* NOT TO SCALE

Kawkawa Creek sketch map (not to scale).

Segment 2 extends 100 m from the culvert crossing on Kawkawa Lake Road, south of Summer Road, east (upstream) to the 100 m marker. This segment is a small (1-2 ft wide, <1 ft deep) tributary that drains into Kawkawa Lake. Spawning habitat is abundant; benthic substrate is largely loose small gravel. There is abundant streamside vegetation to provide cover. The gradient is low and flows are very slow. There is a limited riparian buffer as this segment flows through a residential area.

Segment 3 extends 145 m from its diversion (river right) from segment 2, northeast (upstream) to the 145 m marker. This segment is a small (1-2 ft wide, <1 ft deep) tributary that drains into segment 3. Spawning habitat is abundant; substrate is predominantly loose small gravel. There is abundant streamside vegetation to provide cover. The gradient is low and flows are very slow. There is a limited riparian buffer as this segment flows through a residential area.

Segment 4 extends 90 m from the culvert crossing on Kawkawa Lake Road, just north of Stephens Road, east (upstream) the 90 m marker. This segment is a small (2-4 feet wide, 1-2 feet deep) tributary that drains into Kawkawa Lake. Spawning habitat is abundant; benthic substrate is predominantly loose small gravel and boulders. There is minimal available cover for spawning salmonids. The gradient is steeper than segments 2 and 3, but is still quite low and flows are very slow. There is a limited riparian buffer as this segment flows through a residential area.

Segment 5 extends 110 m from the culvert crossing on Kawkawa Lake Road, north of Kereluk Road, east (upstream) to the 110 m marker. This segment is a small (2-4 feet wide, 1-2 feet deep) tributary that drains into Kawkawa Lake. Spawning habitat is abundant; benthic substrate is predominantly loose small gravel and boulders. There is excellent cover from overhanging streamside vegetation and instream woody debris. The gradient is low and flow is slow. There is a large riparian buffer on both sides as this segment flows through a largely undisturbed deciduous forest.

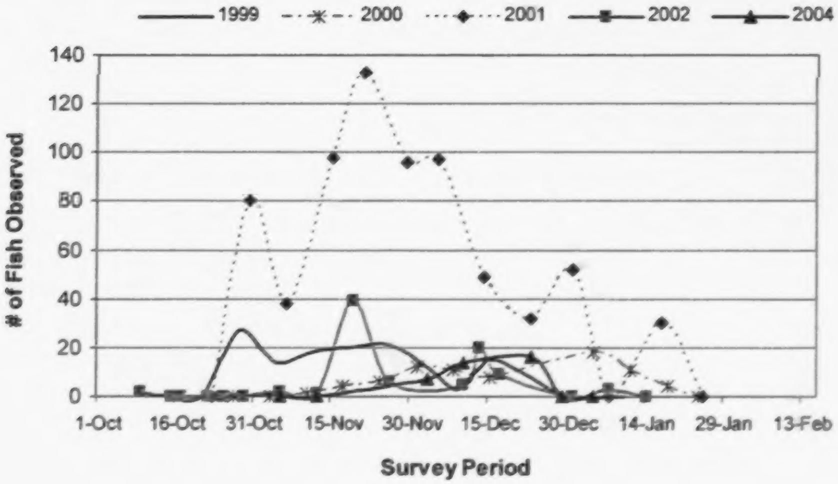
Survey Logistics: Two crew members are required to survey Kawkawa Creek. To access the survey area, the crew drive east on Highway #1 to the city of Hope. In Hope, they head north on Corbett Street, which turns into Kawkawa Lake Road. They follow Kawkawa Lake Road west to Union Bar Road, and turn right (north). To survey segment 1, the crew park the vehicle adjacent to the large beaver dam (when the wetland begins) and survey from the mouth of Kawkawa Creek to the beaver dam, including spawning channel. To survey segments 2-5, they follow Kawkawa Lake Road to the east side of Kawkawa Lake.

Proportion of Spawning Area: Kawkawa Lake is unsurveyable by our crews and may contain some spawning areas. The creek (and tributaries) is almost 100% covered by the survey. The proportion of spawning area covered by the survey, for both chum and coho, is very good to excellent.

RESULTS

Observer Efficiency: Kawkawa Creek had a high average O.E. (0.79 ± 0.10) for all years assessed and was relatively consistent among segments. High visibility in segments 1 and 1A was attributed to excellent water clarity (clear water), substrate type and coloration (high contrast among substrate and spawners), limited instream cover, and channel characteristics (narrow channel widths and shallow water). Visibility was somewhat reduced in these segments by surface glare (high exposure to sunlight). Observer efficiencies were high in segments 2-5 primarily due to channel characteristics (narrow widths and shallow depths) and short survey distances, which increased the detectability of fish; O.E.s of 100% were not uncommon for these segments.

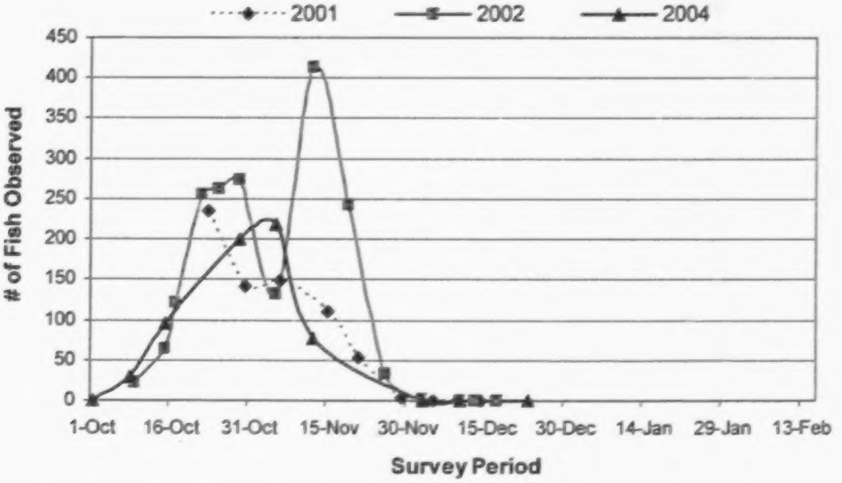
Coho Salmon: Run timing for coho was extremely variable among years, beginning October 9 to December 3, peaking October 28 to January 4, and ending December 21 to January 18. Often there were multiple peak spawning dates. Irregular run timing is most likely attributed to the small numbers of coho that use this creek. Peak counts ranged from 12-133 coho.



Coho escapements ranged from 36-365 in 1999 to 2004 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	108	78	447	60	44	n/a
10	97	70	402	54	39	n/a
11	**89**	**64**	**365**	**49**	**36**	**n/a**
12	81	58	335	45	33	n/a
13	75	54	309	41	30	n/a

Chum Salmon: Run timing for chum was consistent among all years, beginning October 8-23, peaking November 5-12, and ending November 12 to December 15. Peak counts were similar among survey years ranging from 219-414 chum. Run timing was either unimodal or bimodal:



Chum escapements ranged from 424-1,001 in 2001 to 2004 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	529	1,251	742	n/a
9	n/a	n/a	471	1,112	660	n/a
10	**n/a**	**n/a**	**424**	**1,001**	**594**	**n/a**
11	n/a	n/a	385	910	540	n/a
12	n/a	n/a	353	834	495	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.01 fish/m^2 (2004) to 0.086 fish/m^2 (2001), with an average of 0.036 fish/m^2 over 5 years. Average chum spawner density ranged from 0.026 fish/m^2 (2004) to 0.064 fish/m^2 (2002), with an average of 0.045 fish/m^2 over 3 years.

Coho spawning was observed in all six segments, with the greatest proportion of coho observed in segment 1 (average: 0.53). Coho densities were greatest in segments 2 (average: 0.049 fish/m^2) and 4 (average: 0.061 fish/m^2) due to the small size of the survey segments. Little competition for spawning habitat was observed.

The greatest proportion of chum were observed in segment 1 (average: 0.68) and 1A (average: 0.33). Chum spawners observed were evenly distributed with no observed competition for spawning habitat. No chum were observed in segments 2 to 5.

Spawning habitat was limited in segment 1 (predominant substrate: cobbles and boulders) and abundant in segments 1A through 6 (predominant substrate: gravel). In segment 1 and 1A the riparian buffer consisted of a small deciduous forest. In segments 2 to 5, the riparian buffer was extremely limited as these sections flowed through residential properties.

	Concern	Comments
Flow/Gradient		
Spawning Substrate		
Instream Cover		
Adjacent Land Use		
Residential	X	segments 2-5 are adjacent to residential properties
Agricultural		
Roads		
Riparian Buffer	X	limited in segments 2-4; residential development
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Hatchery supplemented	No	not stocked for coho or chum

LITTLE CAMPBELL (CAMPBELL) RIVER

Watershed Code: 900-0005-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

The Little Campbell River is approximately 28 km long (~5.2 km surveyed) and flows west into Boundary Bay. The upper 10 km of the river flow through a wetland mosaic of fens, swamps, and marshes (Campbell River Regional Park). The middle 13 km meanders through agricultural and residential areas. The lower 5 km are slough-like and the river becomes estuarine in the lower 1.5 km. Its major tributaries include Fergus, Sam Hill, Jacobsen and Jenkins Creeks. Located on this river is the Little Campbell hatchery and counting fence located between sections three and four described below. This fence works with both coho and chum salmon and is run by the Semiahmoo Fish and Game Club.

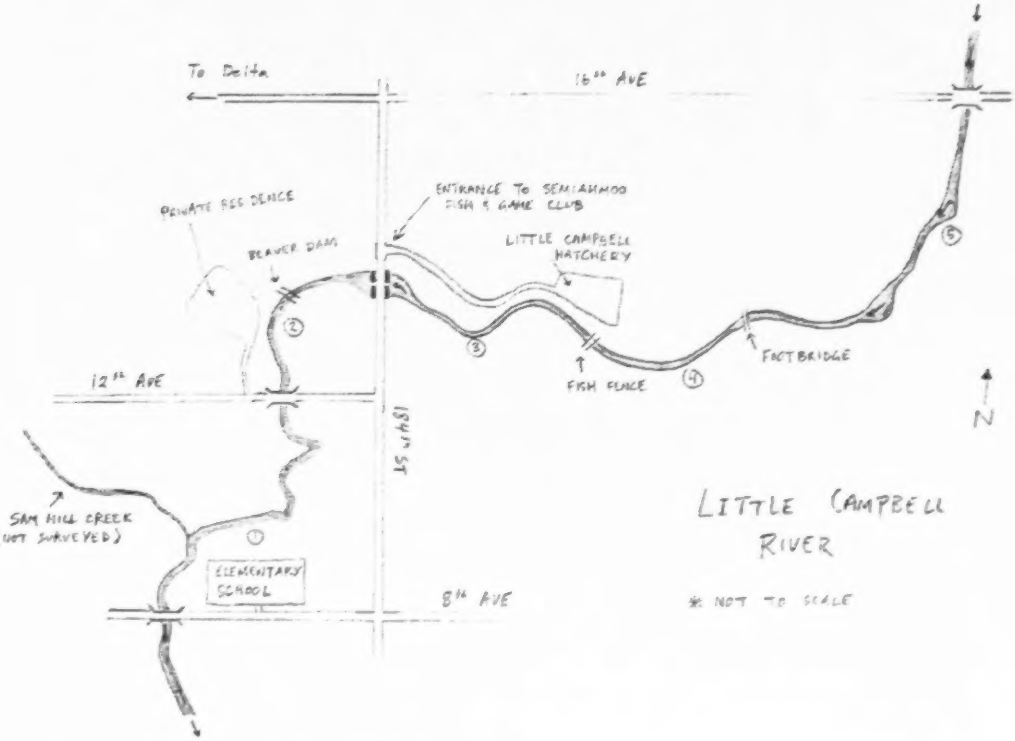
METHODS

Study Area: This river was initially assessed for coho and chum in 2004. The surveyed area extends from the 8th Avenue culvert crossing, northeast to the 16th Avenue bridge crossing. The surveyed segments are as follows:

Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	8 Ave culvert crossing	49°1'0" N 122°43'27" W	12 Ave bridge crossing	49°1'26" N 122°43'10" W	1300	25-30
2	12 Ave bridge crossing	49°1'26" N 122°43'10" W	184 St culvert crossing	49°1'38" N 122°42'48" W	925	15-20
3	184 St culvert crossing	49°1'38" N 122°42'48" W	fish fence	49°1'30" N 122°42'26" W	505	10-15
4	fish fence	49°1'30" N 122°42'26" W	first footbridge crossing	49°1'23" N 122°42'7" W	305	10-15
5	first footbridge crossing	49°1'23" N 122°42'7" W	16 Ave bridge crossing	49°1'52" N 122°41'15" W	2250	60-75

Segment 1 extends 1,300 m from the 8th Avenue culvert crossing, northeast (upstream) to the 12th Avenue bridge crossing. Spawning habitat for coho and chum is limited to the upper sections of this segment; benthic substrate changes from sand and silt in the lower sections to small gravel and sand in the upper sections. Instream cover consists of deep pools, dark water, and overhanging streamside grasses. The gradient is extremely low and water conditions alter from moderate to slow and slough-like. Since this segment flows entirely through an agricultural area, there is no riparian buffer.

Segment 2 extends 925 m from the 12th Avenue bridge crossing, northeast (upstream) to the 184th Street culvert crossing. Spawning habitat is limited; benthic substrate is predominantly fines, although there is abundant gravel in the upper 200 m of the segment. Instream cover is abundant and includes dark water, deep pools, undercuts, and overhanging streamside vegetation. The gradient is low and flow is moderate. There is a limited riparian buffer of shrubs in the upper portion of the segment; the lower half of the segment has no buffer as it flows through agricultural fields.


To Delta
16th AVE
ENTRANCE TO SEMIAHMOO FISH & GAME CLUB
PRIVATE RESIDENCE
BEAVER DAM
LITTLE CAMPBELL HATCHERY
②
③
⑤
FOOTBRIDGE
FISH FENCE
④
12th AVE
N
184th ST
SAM HILL CREEK (NOT SURVEYED)
①
ELEMENTARY SCHOOL
8th AVE
LITTLE CAMPBELL RIVER
* NOT TO SCALE

Little Campbell River sketch map (not to scale).

Segment 3 extends 505 m from the 184th Street culvert crossing, east (upstream) to the fish fence. Spawning habitat is abundant throughout this segment; benthic substrate is predominantly small loose gravel. Similar to segments 1 and 2, this segment has abundant instream cover that includes deep pools, cutbanks, and overhanging streamside vegetation. The gradient increases slightly from the previous segments, flows are moderate and are largely regulated by the fish fence. Since this segment flows through Semiahmoo Fish and Game Club grounds, there is an excellent riparian buffer of deciduous trees and shrubs.

Segments 4 and 5 extend 2,500 m from the fish fence, northeast to the 16th Avenue bridge crossing. Spawning habitat is abundant in this segment; bottom substrate primarily includes small gravel and cobbles. Instream cover is readily available and includes cutbanks, instream woody debris, and deep pools. The gradient is moderate and the flow is slow. In the upper 2 km of the segment there is a wide riparian buffer of mixed forest. The lower sections of these segment flow through residential development and a small riparian buffer is present.

Survey Logistics: A minimum of two crew members are required to survey the Little Campbell River. To access the survey area, the crew drive south on 176th Street (Pacific Highway) and turn left (east) on 8th Avenue. They follow 8th Avenue east to the culvert crossing. To survey segments 1 to 3, one crew member is dropped off at the 8th Avenue culvert crossing; this crew member surveys from the 8th Avenue culvert to the fish fence. The second crew member drives east on 8th Avenue and turns left (north) onto 184th Street. They follow 184th Street to the Semiahmoo Fish and Game Club sign and turn right (west) and follow the road to the fish fence.

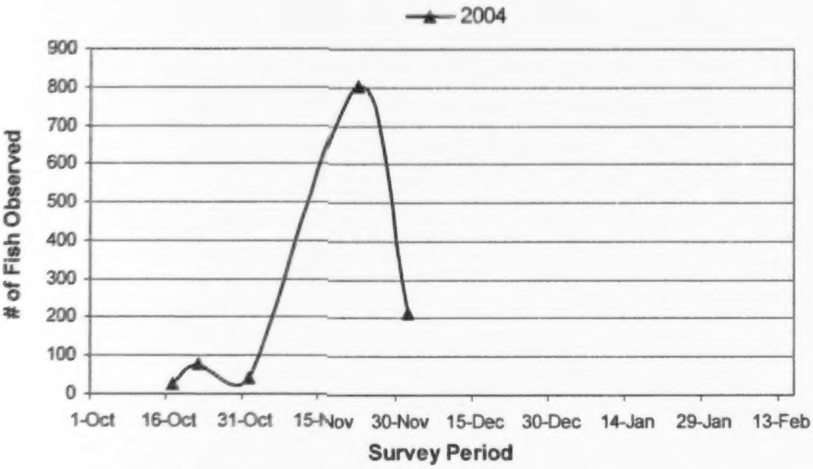
To survey segments 4 and 5, the second crew member surveys from the fish fence to the 16th Avenue bridge crossing, where the first crew member is waiting with the vehicle.

Proportion of Spawning Area: The proportion of spawning area covered by the survey, for coho, is assumed to be good. For chum, the proportion of spawning area covered by the survey is assumed to be good to very good.

RESULTS

Observer Efficiency: Little Campbell River had the lowest average O.E. (0.23 ± 0.07) of all surveyed systems. Within this creek, the highest O.E. was reported for segment 4 (0.39 ± 0.25), and in order of decreasing O.E., segments 5 (0.24 ± 0.05), 3 (0.19 ± 0.18), 1 (0.13 ± 0.05), and 2 (0.13 ± 0.05). Visibility in segments 4 and 5 were similar and were reduced minimally by surface glare and instream cover (deep pools with dark water and cutbanks). Segment 3 transitions among segments 4 and 5 (higher O.E.) and 1 and 2 (lower O.E.); as a result, segment 3's O.E. is intermediate among these segments. The lowest O.E. was reported for segments 1 and 2. Visibility in these segments was reduced by water clarity (dark coffee color), surface glare particularly in the morning (limited riparian buffer and high exposure to sunlight), and the presence of instream cover (cutbanks and deep pools). Segments 1 and 2 flow through open agricultural areas. In future years the use of Little Campbell fence counts to validate O.E. should be investigated.

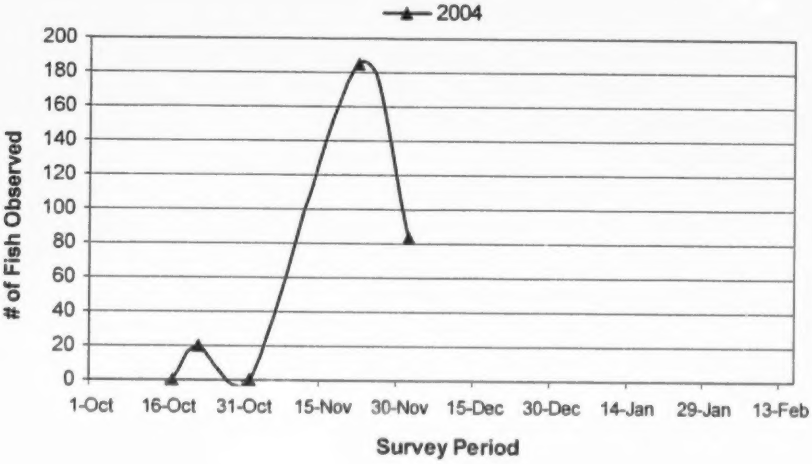
Coho Salmon: Run timing for coho was only assessed in 2004, beginning October 16 (commencement of surveys), peaking November 22, and ending December 2 (end of surveys). The peak count was 804 coho. Although incomplete, run timing appears to be unimodal with one peak spawn:



Coho escapement in 2004 was 1,379 (R.T.: 11 days); the entire run was not assessed so this escapement estimate could be negatively biased.

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	n/a	n/a	1,686	n/a
10	n/a	n/a	n/a	n/a	1,517	n/a
11	**n/a**	**n/a**	**n/a**	**n/a**	**1,379**	**n/a**
12	n/a	n/a	n/a	n/a	1,265	n/a
13	n/a	n/a	n/a	n/a	1,167	n/a

Chum Salmon: Run timing for chum was only assessed in 2004, beginning October 22, peaking November 22, and ending December 2 (end of surveys). The peak count was 185 chum. Although incomplete, run timing appears to be unimodal run timing with one peak spawn:



Chum escapement in 2004 was 377 (R.T.: 10 days); the entire run was not assessed so this escapement estimate could be negatively biased.

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	n/a	n/a	471	n/a
9	n/a	n/a	n/a	n/a	419	n/a
10	**n/a**	**n/a**	**n/a**	**n/a**	**377**	**n/a**
11	n/a	n/a	n/a	n/a	343	n/a
12	n/a	n/a	n/a	n/a	314	n/a

Spawner Densities: Spawner density was only assessed in 2004; average coho density: 0.019 fish/m^2; average chum density 0.01 fish/m^2. The greatest proportion of coho (0.83) and chum (0.91) was observed in segment 5. Spawning densities for coho increased moving upstream, with the greatest densities occurring in segments 4 (0.031 fish/m^2) and 5 (0.035 fish/m^2). Spawning densities for chum were relatively low in all segments with the exception of segment 5. Spawning habitat did not appear to be limiting with very little intra- and inter-species competition observed.

Spawning habitat was limited in segments 1 and 2; benthic substrate was predominantly sand and silt with gravel occurring only in the upper 200 m of segment 2. In segments 3-5, spawning habitat was abundant with suitable spawning substrate and instream cover. The riparian buffer was most significant in segments 3-5; segments 1 and 2 were adjacent to agricultural land.

	Concern	Comments
Flow/Gradient		
Spawning Substrate		
Instream Cover	X	limited in segments 1 and 2
Adjacent Land Use		
Residential		
Agricultural	X	large portion of surveyed area flows through agricultural land; cattle and other livestock observed adjacent to river
Roads		
Riparian Buffer		
Stream bank erosion	X	segments 1 and 2: stream banks are steep and erosion observed is considerable
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous	X	water pumps observed in segments 4 and 5; unquantified water extraction
Hatchery supplemented	Yes	coho and chum are stocked by the Semiahoo Fish and Game Club (Little Campbell River Hatchery)

The total number and average weight of coho juveniles stocked into the Little Campbell River from 1999 to 2005 (chum were not enhanced):

Species	Release Year	# Released	Avg. Weight (g)
COHO	1999	25,381	18.7
	2000	29,752	13
	2001	39,269	30.8
	2002	17,807	12.4
	2003	39,513	26.2
	2004	50,884	18.6
	2005	23,164	23.4

Fence counts of coho and chum in the Little Campbell River from 1999 to 2005:

Species	Year	Wild Adults	Wild Jacks	Total Wild	Hatchery Adults	Hatchery Jacks	Total Hatchery	TOTAL
COHO	1999	1,340	74	*1,414*	83	15	*98*	**1,512**
	2000	1,275	53	*1,328*	89	30	*119*	**1,447**
	2001	3,181	532	*3,713*	474	92	*566*	**4,279**
	2002	4,547	156	*4,703*	388	136	*524*	**5,227**
	2003	3,345	82	*3,427*	245	13	*258*	**3,685**
	2004	1,384	95	*1,479*	131	32	*163*	**1,642**
	2005	2541	111	2652	731	148	879	**3531**
CHUM	1999	584	n/a	n/a	n/a	n/a	n/a	**584**
	2000	230	n/a	n/a	n/a	n/a	n/a	**230**
	2001	114	n/a	n/a	n/a	n/a	n/a	**114**
	2002	475	n/a	n/a	n/a	n/a	n/a	**475**
	2003	289	n/a	n/a	n/a	n/a	n/a	**289**
	2004	126	n/a	n/a	n/a	n/a	n/a	**126**
	2005	273	n/a	n/a	n/a	n/a	n/a	**273**

LITTLE STAWAMUS RIVER

Watershed Code: 900-091000-00000-00000-0000-0000-000-000-000-000-000-000

CREEK DESCRIPTION

Little Stawamus River is approximately 4 km long (~1.7 km surveyed) and flows southwest from its headwaters (Squamish) to the Stawamus River and subsequently into Howe Sound. The surveyed portion of the creek flows primarily through undisturbed forest and residential (often adjacent to backyards) areas.

METHODS

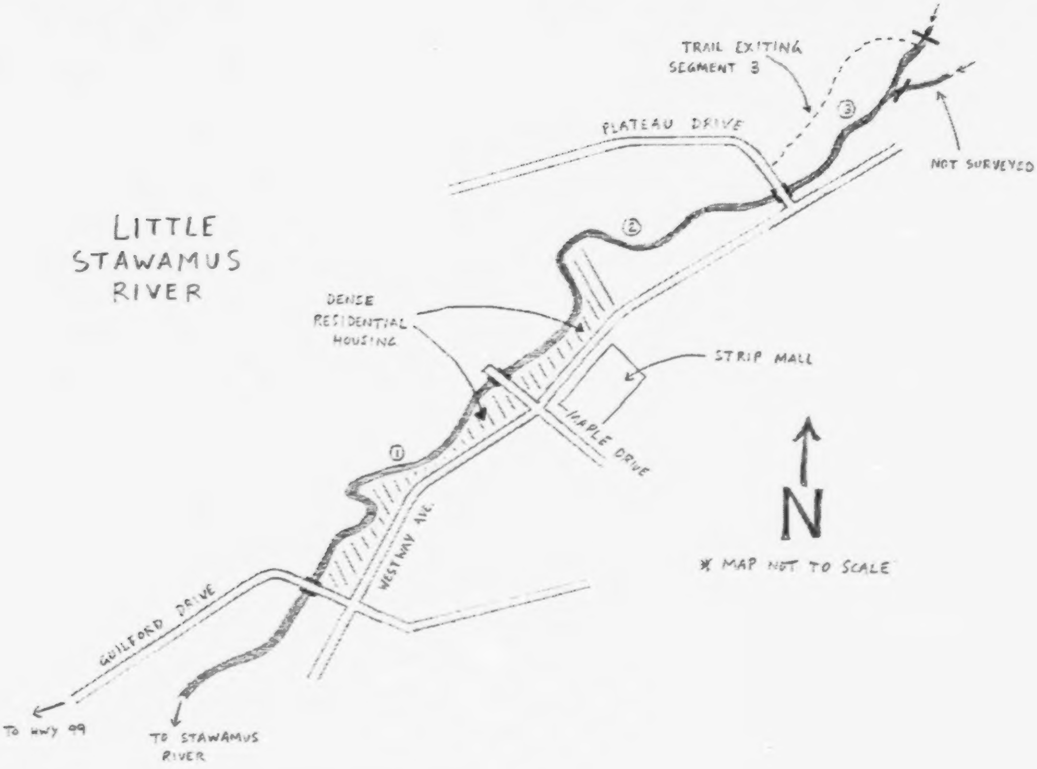
Study Area: This creek was surveyed from 1999 to 2004 (excluding 2003) for coho and from 2001 to 2004 (excluding 2003) for chum. A third survey segment was added (350 m) in 2002 and was continued in 2004 surveys. Segment 1 and two boundaries have been identical for all five survey years. The surveyed area extends from the bridge crossing at Guildford Drive to northeast to the culvert crossing at Plateau Drive. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Guildford Drive culvert crossing	49°41'52" N 123°8'18" W	Maple Drive culvert crossing	49°42'5" N 123°7'57" W	610	20-30
2	Maple Drive culvert crossing	49°42'5" N 123°7'57" W	Plateau Drive culvert crossing	49°42'21" N 123°7'13" W	750	25-35
3	Plateau Drive culvert crossing	49°42'21" N 123°7'13" W	marker just above split in channel	49°42'27" N 123°6'58" W	350	10-20

Segment 1 extends 610 m from the Guildford Drive culvert crossing, northeast (upstream) to the Maple Drive culvert crossing. Spawning habitat is abundant throughout the entire segment; benthic substrate includes loose gravel and cobbles. There is abundant instream cover that includes overhanging vegetation, cutbanks, canopy closure, and instream woody debris. The gradient is quite low and the flow is moderate. The entire segment flows through a residential area. On the east side of the creek there is no riparian buffer and on the west side of the creek there is a relatively large buffer of undisturbed mixed wooded forest.

Segment 2 extends 750 m from the Maple Drive culvert crossing, north (upstream) to the Plateau Drive culvert crossing. Spawning habitat in this segment is abundant; benthic substrate changes from loose gravel and cobbles to increasingly bouldered in the upper sections of this segment. Instream cover is limited to canopy closure and cutbanks. The gradient is low and flow is moderate. There is a limited riparian buffer due to the segment's proximity to residential housing on both banks.

Segment 3 extends 350 m from the Plateau Drive culvert crossing, northwest (upstream) to the marker at the fork in channel. Spawning habitat is limited to the lower sections of the segment; benthic substrate changes from loose gravels in the lower sections to sands and silts in the upper sections. There is excellent instream cover in the form of canopy closure and instream large woody debris. Flow is moderate due to relatively level gradient. There is an excellent mixed-forest riparian buffer on either bank as the creek channel diverges from surrounding residential development.


TRAIL EXITING SEGMENT 3
③
NOT SURVEYED
PLATEAU DRIVE
LITTLE STAWAMUS RIVER
②
DENSE RESIDENTIAL HOUSING
STRIP MALL
①
MAPLE DRIVE
WESTWAY AVE.
N
* MAP NOT TO SCALE
GUILFORD DRIVE
TO HWY 99
TO STAWAMUS RIVER

Little Stawamus River sketch map (not to scale).

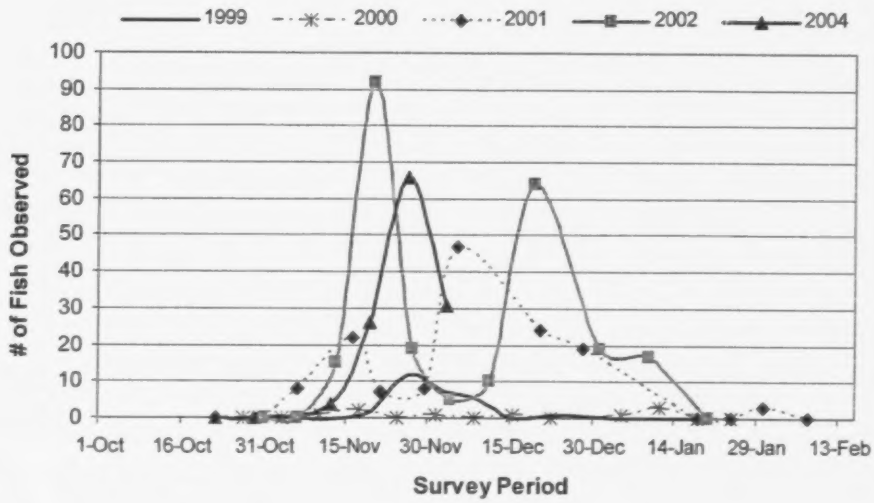
Survey Logistics: Two crew members are required to survey Little Stawamus River. To access the survey area, the crew drive north on Highway 99 (towards Whistler) and turn right (east) onto Valley Drive. They follow Valley Drive (turns into Guildford Drive) east to the culvert crossing. To survey segment 1, a crew member surveys from the culvert on Guildford Drive to the culvert crossing on Maple Drive, where the vehicle has been parked by the second crew member. To survey segments 2 and 3, the second crew member walks from the culvert on Maple Drive where the vehicle is parked, to the marker at the channel split. The second crew member can exit via the trail on river right to the Plateau Drive culvert crossing, where the first crew member can wait with the vehicle

Proportion of Spawning Area: Some upper and lower regions of the creek are unsurveyed. The proportion of spawning area covered by the survey, for both coho and chum, is assumed to be moderate to good.

RESULTS

Observer Efficiency: Little Stawamus River had a high average O.E. (0.73 ± 0.15) for all years assessed O.E. is relatively consistent among survey segments: segment 1 average: 0.73 ± 0.11; segment 2 average: 0.74 ± 0.08; and segment 3 average: 0.76 ± 0.10. Relatively high observer efficiencies can be attributed to good water clarity (clear water), minimal surface glare (limited exposure to sunlight), and favorable channel characteristics (low flows, shallow water, and narrow channel widths). Visibility was reduced by the presence of abundant cover habitat (woody debris and cutbanks).

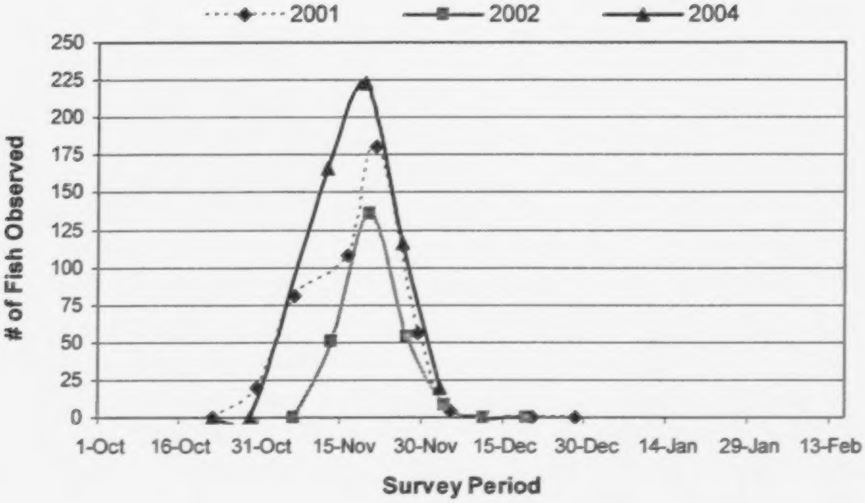
Coho Salmon: Run timing for coho was variable among years, beginning November 6-18 and ending December 22 to January 30. Run timing was bimodal with two distinct spawns; the initial spawn ranged from November 16-26; secondary spawn ranged from December 5-19. Peak counts were also variable among survey years ranging from 3-92 coho:



Coho escapements ranged from 6-248 in 1999 to 2004 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	22	8	133	303	99	n/a
10	19	7	119	273	89	n/a
11	**18**	**6**	**108**	**248**	**81**	**n/a**
12	16	6	99	227	74	n/a
13	15	5	92	210	69	n/a

Chum Salmon: Run timing for chum was consistent among years, beginning October 30 to November 13, peaking November 19-21, and ending December 3-5. Peak counts were relatively consistent among survey years ranging from 126-223 chum. Run timing was unimodal with one peak spawn:



Chum escapements ranged from 175-420 in 2001 to 2004 (R.T.: 10 days):

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	343	219	525	n/a
9	n/a	n/a	305	194	467	n/a
10	**n/a**	**n/a**	**275**	**175**	**420**	**n/a**
11	n/a	n/a	250	159	382	n/a
12	n/a	n/a	229	146	350	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.0001 fish/m^2 (2000) to 0.008 fish/m^2 (2002), with an average of 0.003 fish/m^2 over 5 years. Average chum spawner density ranged from 0.011 fish/m^2 (2002) to 0.026 fish/m^2 (2004), with an average of 0.019 fish/m^2 over 3 years.

Coho were distributed throughout the surveyed area, with the highest proportions observed in segment 2 (average: 0.62) with fewer coho observed in segment 1 (0.29). Although the total numbers of coho were greater in segment 2, densities of fish observed were similar in segment 1. Spawning habitat was not observed to be limiting.

The highest proportion of chum was observed in segment 1 (average: 0.74), with fewer chum observed in segment 2 (average: 0.25) and almost no chum observed in segment 3. Chum densities were also greatest in segment 1. Spawning habitat did not appear to be limiting, although slight redd overlap was observed during the peak of chum spawning in segment 1 over all survey years.

Spawning habitat was abundant in segments 1 and 2; benthic substrate was predominantly smaller gravel and cobble. Segment 3 has minimal spawning habitat as suitable substrate was extremely limited. In all three segments instream cover was abundant and riparian buffers were moderate.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	limited substrate in segment 3
Instream Cover		
Adjacent Land Use		
Residential	X	segments 1 and 2 flow through residential development
Agricultural		
Roads		
Riparian Buffer	X	no buffer on the east side of segments 1 and 2 since they flow through residential properties
Stream bank erosion		
Garbage	X	considerable garbage observed in the creek
Spawning disturbance		
Beaver activity		
Hatchery supplemented	No	not stocked for coho or chum

MASHITER CREEK

Watershed Code: 900-097600-05100-08900-0000-0000-000-000-000-000-000-000

CREEK DESCRIPTION

Mashiter Creek is approximately 7 km long (~0.6 km surveyed) and flows southwest from its headwaters and enters the Mamquam River approximately 2 km east of Highway 99 in the Squamish area. Most sections of this creek run through undisturbed deciduous forest, the lower region of the creek runs adjacent to a small scrap metal plant. The creek is fast flowing and susceptible to flash flooding.

METHODS

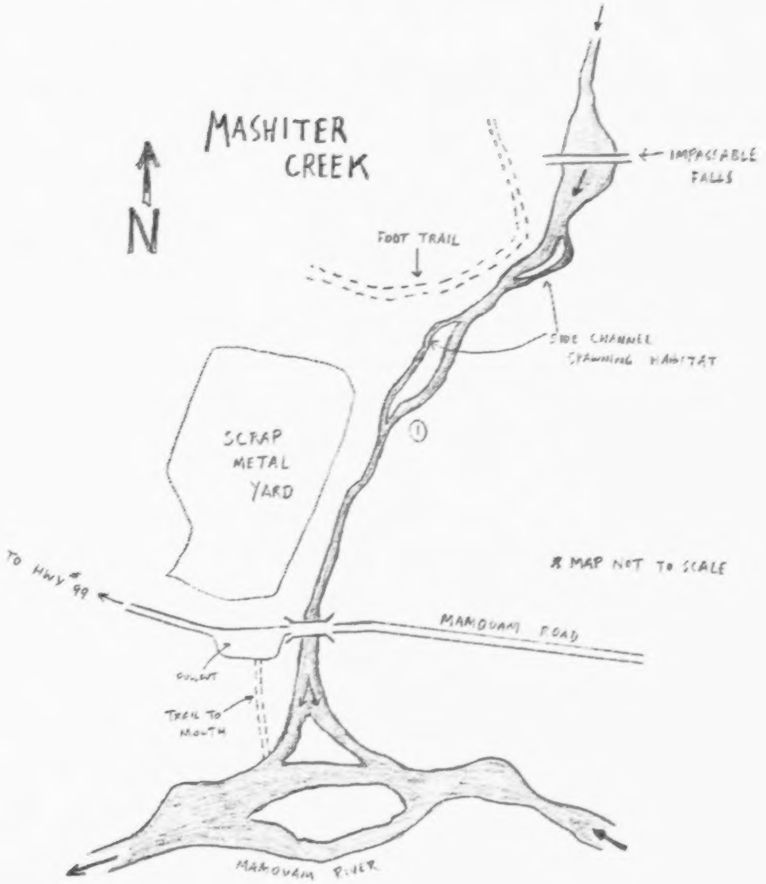
Study Area: This creek was surveyed for coho from 1999 to 2004 (excluding 2002 and 2003) and for chum in 2001 and 2004. Survey segment distances and upper and lower boundaries are identical for all four survey years. The surveyed area extends from Mashiter Creek's confluence with the Mamquam River, north to the non-passable falls. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Confluence w/ Mamquam River	49°44'1" N 122°6'52" W	falls	49°44'26" N 122°6'17" W	630	30-40

Segment 1 extends 630 m from Mashiter Creek's confluence with Mamquam River, north (upstream) to the falls. Spawning habitat in this segment is largely restricted to the side channels; side channel benthic substrate includes small-sized gravel, while mainstem substrate is predominantly large cobbles and boulders. Instream cover is limited and includes overhanging vegetation, tight canopy closure, and small amounts of instream woody debris. Additionally, a large pool downstream of the falls provides cover for salmon. The gradient in this creek is steep and the creek can have extremely high flows during periods of increased rainfall. There is a buffer of mixed-wood forest along the majority of the creek with the exception of the lower portions that flow through an industrial area.

Survey Logistics: Two crew members are required to survey Mashiter Creek. To access the survey area, the crew drive north on Highway 9[illegible] and turn right (east) on Mamquam River Road. They follow Mamquam River Road east to the Mashiter Creek bridge crossing and park the vehicle. To survey segment 1, one crew member walks to the mouth of Mashiter Creek (south of bridge) and survey north to the falls. They exit the creek and walk downstream (south) to bridge crossing to return to the vehicle.

Proportion of Spawning Area: The entire creek is covered by the survey, aside from a very small portion near the mouth. The proportion of spawning area covered by the survey, for both coho and chum, is very good to excellent.

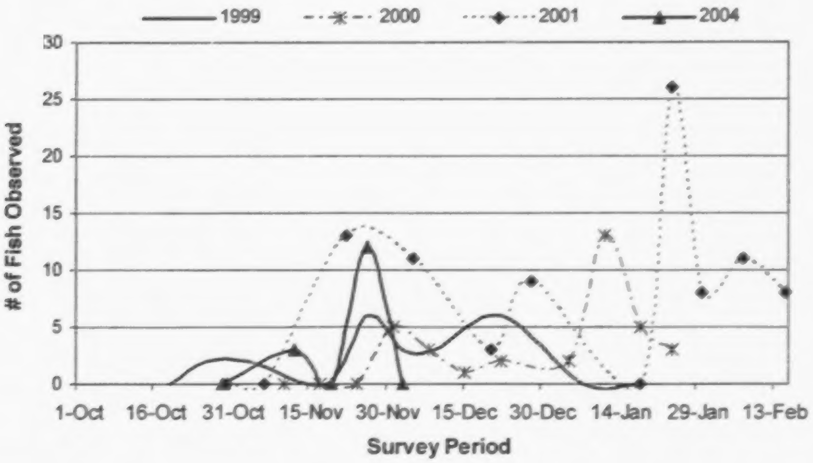

MASHITER CREEK
N
IMPASSABLE FALLS
FOOT TRAIL
SIDE CHANNEL SPAWNING HABITAT
①
SCRAP METAL YARD
* MAP NOT TO SCALE
TO HWY # 99
MAMQUAM ROAD
CULVERT
TRAIL TO MOUTH
MAMQUAM RIVER

Mashiter Creek sketch map (not to scale).

RESULTS

Observer Efficiency: Mashiter Creek had a moderate average O.E. (0.67 ± 0.14) for all years assessed. Good stream visibility was attributed to water clarity (clear water), small numbers of fish observed, limited instream cover and relatively shallow water. Visibility in the creek was reduced by substrate colour (substrate colour very similar to chum spawning colours), greater flows, and wide channel width.

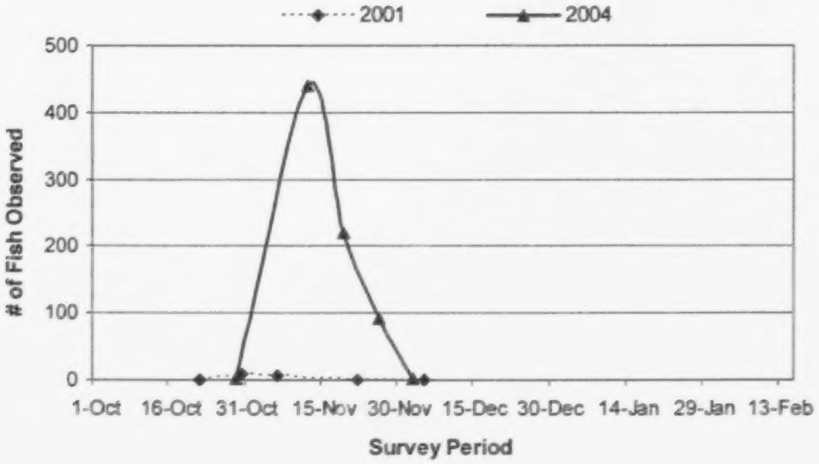
Coho Salmon: Run timing for coho was considerably variable among years, beginning October 26 to December 1, peaking November 22 to January 24, and ending from December 22 to February 15. Irregular run timing are most likely attributed to the small numbers of coho that spawn in this creek:



Coho escapements ranged from 11-72 in 1999 to 2004 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	20	26	88	n/a	13	n/a
10	18	23	80	n/a	12	n/a
11	**17**	**21**	**72**	**n/a**	**11**	**n/a**
12	15	19	66	n/a	10	n/a
13	14	18	61	n/a	9	n/a

Chum Salmon: Run timing for chum was variable among years, beginning October 29 to November 9, peaking October 30 to November 13 and ending December 3-23. Peak counts ranged from 9 to 440 chum. Run timing in 2004 was unimodal with one peak spawn:



Chum escapements ranged from 11-684 in 2001 and 2004 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	13	n/a	855	n/a
9	n/a	n/a	12	n/a	760	n/a
10	**n/a**	**n/a**	**11**	**n/a**	**684**	**n/a**
11	n/a	n/a	10	n/a	622	n/a
12	n/a	n/a	9	n/a	570	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.001 fish/m^2 (1999 and 2000) to 0.033 fish/m^2 (2002), with an average of 0.009 fish/m^2 over 4 years. Average chum spawner density ranged from 0.001fish/m^2 (2001) to 0.024 fish/m^2 (2004), with an average of 0.013 fish/m^2 over 2 years.

Both coho and chum spawning activity is limited in the main channel where substrate is generally not suitable for spawning. In the main channel, chum spawning largely occurred on gravel deposits in low velocity areas along channel margins. Most chum spawning was observed on the alluvial fan at the stream mouth, where there is abundant loose gravel suitable for spawning.

	Concern	Comments
Flow/Gradient	X	in segment 1 the gradient is steep and flows can be rapid during rain events
Spawning Substrate	X	in segment 1 substrate is limited to side channels only
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer	X	limited in the lower sections of segment 1 where the creek flows through industrial property
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous		scrap metal yard on Mamquam road is adjacent to creek and no control measures have been observed to minimize runoff
Hatchery supplemented	No	not stocked for coho or chum

McINTYRE CREEK

Watershed Code: 100-0267-137-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

McIntyre Creek is approximately 3 km long (~1.3 km surveyed) and flows southeast into the Lower Pitt River north of Port Coquitlam. The creek originates on Burke Mountain and has a watershed area of 8 km^2 (Schubert 1982), with its major tributary being Deiner Creek. The surveyed segments primarily flow through undisturbed mixed forest, with the lower sections of the creek flowing through the Widgeon Valley National Wildlife Area.

METHODS

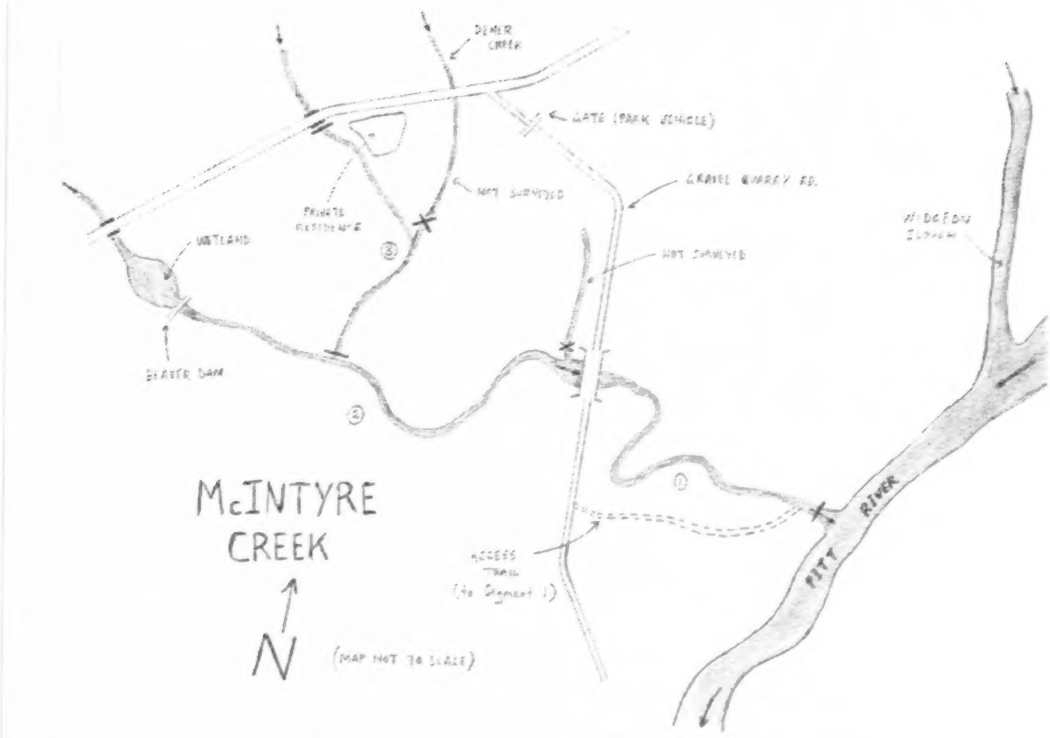
Study Area: This creek was surveyed for coho from 1999 to 2004 (excluding 2003) and for chum from 2001 to 2004 (excluding 2003). In 1999 and 2000, there were two additional survey segments (upstream of beaver dam to gravel road and a tributary located slightly upstream of the major beaver dam; river left). Upper and lower boundaries for segments 1-3 have been identical for all five survey years. The surveyed area extends from McIntyre Creek's confluence with the Pitt River, northwest to the culverts at Minnekhada Trail Road. The surveyed segments are as follows:

Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	mouth (confluence w/ Pitt River)	49°18'50" N 122°40'53"W	first footbridge	49°19'1" N 122°41'36" W	650	30-40
2	first footbridge	49°19'31" N 122°42'27" W	large beaver dam	49o19'1" N 122o41'36" W	500	10-20
3	second trib after footbridge (river left)	49°19'1" N 122°41'36" W	culverts at logging road	49°19'32" N 122°42'45" W	145	20-30

Segment 1 extends 650 m from McIntyre Creek's confluence with Pitt River, northwest (upstream) to the footbridge bridge crossing. Spawning habitat is limited to the scattered riffles within the segment. Benthic substrate is predominantly sand, with scattered gravel deposits. Instream cover is abundant and includes many deep pools, cutbanks, overhanging vegetation, and instream large woody debris. The gradient of this segment is very low and is characterized by slow, deep, slough-like water. It is influenced by tidal activity and is susceptible to flooding and siltation. This segment has a wide riparian buffer of undisturbed mixed forest (Widgeon Valley National Wildlife Area).

Segment 2 extends 500 m from the footbridge crossing, northwest (upstream) to the large beaver dam. Spawning habitat in this segment is abundant; benthic substrate is sand in the lower sections, changing to small loosened gravel in the upper sections. Instream cover is abundant and includes many deep pools, cutbanks, overhanging vegetation, and instream large woody debris. The gradient is low and flows are slow. This segment has many braids and a single defined channel can be difficult to identify. There is an excellent riparian buffer of undisturbed forest.

Segment 3 extends 145 m from the marker on McIntyre, northwest (upstream) to the culverts at the logging road. Ideal spawning habitat is abundant throughout this segment; benthic substrate includes small cobbles and boulders. Instream cover is also abundant in the form of cutbanks, overhanging vegetation, instream woody debris, and tight canopy closure. There is an excellent riparian buffer of mixed forest on either bank.


DEINER CREEK
GATE (PARK VEHICLE)
NOT SURVEYED
GRAVEL QUARRY RD.
PRIVATE RESIDENCE
WETLAND
WIDGEON SLOUGH
NOT SURVEYED
③
BEAVER DAM
②
①
PITT RIVER
McINTYRE CREEK
ACCESS TRAIL (to Segment 1)
N
(MAP NOT TO SCALE)

McIntyre Creek sketch map (not to scale).

Survey Logistics: Two crew members are required to survey McIntyre Creek. To access the survey area, the crew drive west towards Coquitlam on Lougheed Highway and turn right (north) onto Coast Meridian Road. On Coast Meridian Road, they follow the signs to Minnekhada Regional Park (trails) and then follow the gravel road to a gate, located slightly north of the Deiner Creek crossing, and park the vehicle. Both crew members walk past the gate, southwest down the quarry road to the trail 25 m past the footbridge. They follow this trail to the mouth of McIntyre Creek. To survey segment 1, both crew members walk northwest (upstream) from the mouth to the footbridge. To survey segment 2, the crew survey from the bridge to the old beaver dam. To survey segment 3, the crew walk downstream from the beaver dam to the mouth of segment 3 (river left), then survey upstream to the culvert crossing.

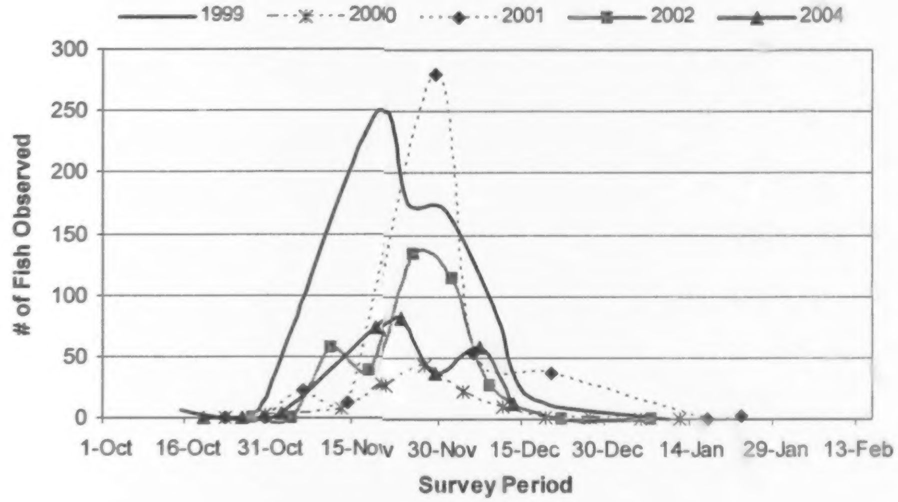
NOTE: *The area that drains into McIntyre Creek has numerous channels that spring from underground sources and provide good spawning grounds intermittently.*

Proportion of Spawning Area: The survey area extends from the mouth up to steep gradients and unfavorable spawning areas. The proportion of spawning area covered by the survey is assumed to be very good to excellent.

RESULTS

Observer Efficiency: McIntyre Creek had a moderate average O.E. (0.69 ± 0.13) for all segments and years assessed. Among survey segments, O.E. was relatively consistent; O.E. is slightly higher in segment 3 (average: 0.73 ± 0.11) versus segments 1 (average: 0.69 ± 0.12) and 2 (average: 0.64 ± 0.15). Segment 3's higher O.E. can be attributed to its reduced surface glare (minimal exposure to sunlight), limited instream cover, low flow and channel characteristics (shallow water and narrow channel width). Lower O.E. in segment 1 can be attributed to increased surface glare, instream cover (cutbanks and woody debris) and channel characteristics (deep water and wide channel widths). Observer efficiency in segment 2 is primarily affected by instream cover (cutbanks and woody debris) and channel characteristics (channel braiding). Water clarity is excellent in all of the survey segments.

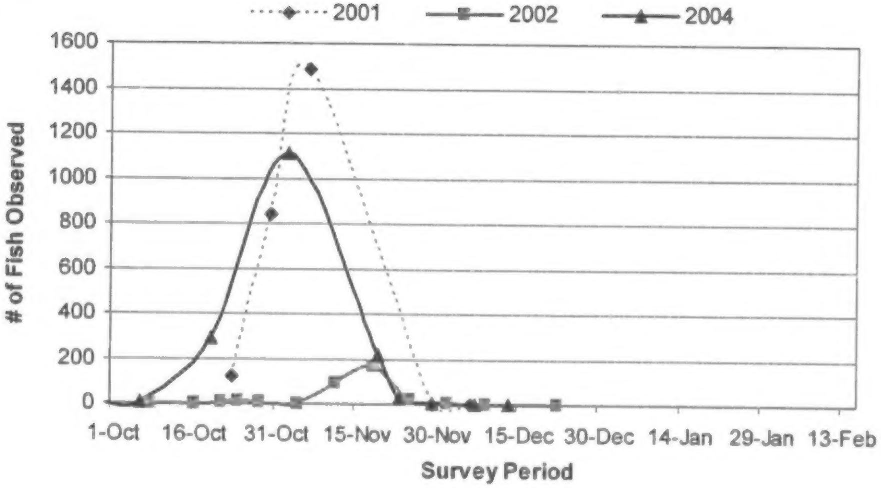
Coho Salmon: Run timing for coho was moderately variable among years, beginning October 15 to November 11, peaking November 19-29, and ending December 9 to January 23. Peak visual counts ranged from 44-280 coho. Run timing was generally unimodal with one peak spawn, especially during years with increased run sizes. Years with smaller run sizes exhibited a slight bimodal run timing trend, often with two or more peak spawns:



Coho escapements ranged from 74-615 in 1999 to 2004 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	752	90	346	296	215	n/a
10	677	81	312	266	194	n/a
11	**615**	**74**	**283**	**242**	**176**	**n/a**
12	564	68	260	222	161	n/a
13	521	62	240	205	149	n/a

Chum Salmon: Run timing for chum was consistent among years, beginning October 6-23, peaking November 2-19, and ending November 13 to December 9. Peak counts ranged from 170- 1,485 chum. Run timing was unimodal with one peak spawn:



Chum escapements ranged from 215-2,281 in 2001 to 2004 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	2,224	268	2,851	n/a
9	n/a	n/a	1,977	238	2,535	n/a
10	**n/a**	**n/a**	**1,779**	**215**	**2,281**	**n/a**
11	n/a	n/a	1,617	195	2,074	n/a
12	n/a	n/a	1,483	179	1,901	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.007 fish/m^2 (2000) to 0.047 fish/m^2 (2002), with an average of 0.028 fish/m^2 over 5 years. Average chum spawner density ranged from 0.008 fish/m^2 (2002) to 0.11 fish/m^2 (2004), with an average of 0.059 fish/m^2 over 3 years.

The largest proportion of coho were observed in segment 1 (average: 0.56) followed by segment 2 (average: 0.33). The largest proportions of chum were observed in segment 1 (average: 0.74). Little chum spawning activity was observed in segment 3.

Spawning habitat was abundant in segments 2 and 3; benthic substrate was almost entirely small gravel and cobble. In segment 1, spawning habitat was limited to the upper sections; benthic substrate changed from fines (sand and silt) to small gravel and cobble. The water levels in the lower sections of segment 1 also fluctuated regularly since these sections were tidally influenced. Instream cover (cutbanks, instream woody debris, etc.) was abundant in all segments; segments one and two, however, were directly exposed to sunlight. All three survey segments had substantial mixed-wood riparian buffers.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	segment 1 has limited spawning habitat (predominantly sand)
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer		
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

NATHAN (GLEN, BEAVER) CREEK

Watershed Code: 100-0437-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Nathan Creek is approximately 15 km long (~4 km surveyed) and flows north into the south side of the Fraser River, 2 km west of Crescent Island. There are no major tributaries. The upper 8 km of the creek flows through a dense second growth forest, entering into a deep gulley at 7 km. At 3.5 km the gulley ends and the creek flows across farmland in a channelized and dyked stream bed. The lower 1.8 km is slough-like (Schubert 1982).

METHODS

Survey Area: This creek was surveyed for coho from 1999 to 2004 (excluding 2003) and for chum from 2001 to 2004 (excluding 2003). In 2002, there were a total of nine survey segments, but the upper and lower survey area boundaries were identical. The surveyed area extends from the marker located 500 m downstream of the Nathan Avenue bridge crossing, south to the Townshipline Road bridge crossing. The surveyed segments are as follows:

Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	marker ~ 500m d/s of Nathan ave	49°7'7" N 122°27'49" W	Nathan Ave bridge crossing	49°6'51" N 122°27'10" W	500	10-15
2	Nathan Ave bridge crossing	49°6'51" N 122°27'10" W	56 Ave crossing	49°6'13" N 122°27'32" W	1200	35-50
3	56 Ave crossing	49°6'13" N 122°27'32" W	Train tracks	49°6'3" N 122°27'28" W	600	15-20
4	Train tracks	49°6'3" N 122°27'28" W	Myrtle Ave crossing	49°5'55" N 122°27'26" W	350	10-15
5	Myrtle Ave crossing	49°5'55" N 122°27'26" W	Townshipline Rd crossing	49°5'22" N 122°27'33" W	1300	45-60

Segment 1 is 500 m long, commencing at the marker located 50 m downstream of the Nathan Avenue bridge crossing. There is limited spawning habitat for coho and chum in the segment; benthic substrate consists of a mixture ranging from small gravel to large boulders. There is abundant cover from undercuts, instream woody debris, overhanging streamside vegetation and deep pools. The gradient is moderate and flows are slow, except during periods of increased rainfall. There is an excellent riparian buffer of mixed deciduous forest and grasses.

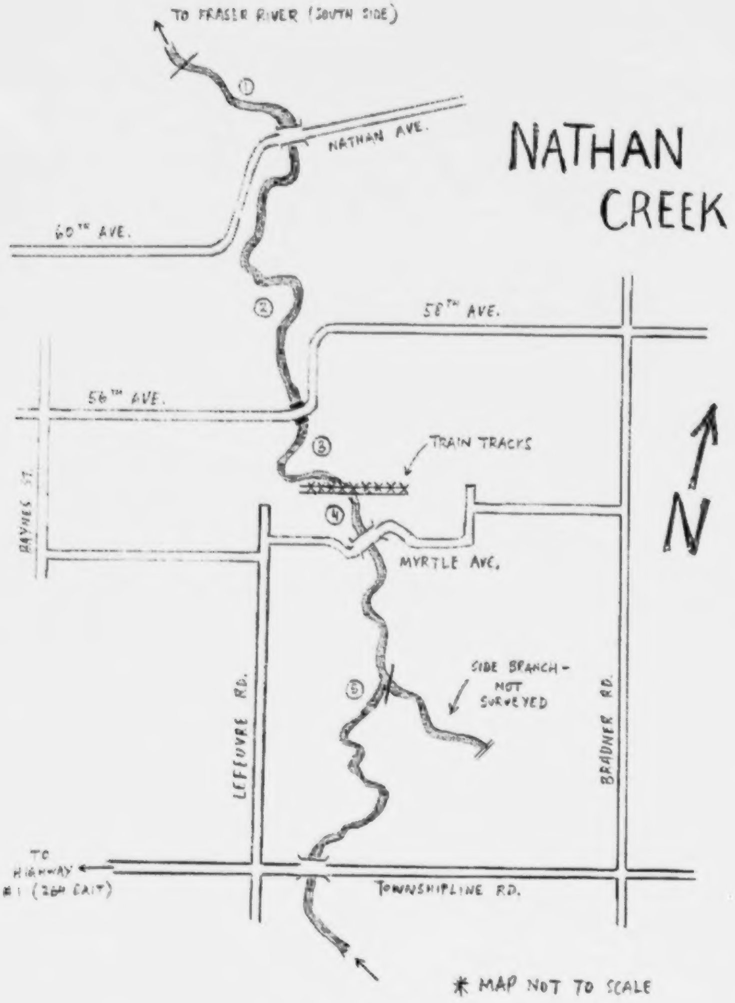
Segment 2 extends 1.2 km from the Nathan Avenue bridge crossing, south (upstream) to the 56th Avenue bridge crossing. There is excellent spawning habitat for coho and chum throughout the entire segment; bottom substrate is largely composed of small gravel and cobbles. There is limited cover from overhanging streamside vegetation and deep pools. The gradient is moderate and flows are slow. There is a broad riparian buffer of mixed forest.

Segment 3 extends 600 m from the 56th Avenue bridge crossing, southwest (upstream) to the train track crossing. There is minimal spawning habitat available in this segment; substrate is predominantly comprised of medium sized cobbles, interspersed with limited, yet ideal pockets of spawning gravel. There is minimal cover from deep pools, undercuts and overhanging streamside vegetation. The gradient is gradual and flows are slow. There is a moderate riparian buffer of small shrubs and grasses.

Segment 4 extends 350 m from the train track crossing, south (upstream) to the Myrtle Avenue bridge crossing. This segment exhibits excellent spawning habitat for coho and chum; substrate is mainly composed of small loosened gravel. Much of the segment is highly exposed, while there is some cover available from deep pools and undercuts. The gradient is moderate and flows are slow. There is a moderate riparian buffer of small shrubs and grasses.

Segment 5 extends 1.3 km from the Myrtle Avenue bridge crossing, south (upstream) to the Townshipline Road bridge crossing. There is excellent spawning habitat throughout the entire segment; bottom substrate is predominantly comprised of small slightly embedded gravel. The majority of the segment is exposed, although some cover is available from deep pools, cutbanks and canopy closure. The gradient is moderate and flows are slow. There is a moderate riparian buffer of small shrubs and grasses.

***NOTE:** The surveyed portion of Nathan Creek experiences flash floods during heavy rain.*


TO FRASER RIVER (SOUTH SIDE)
①
NATHAN AVE.
NATHAN
CREEK
60TH AVE.
②
58TH AVE.
56TH AVE.
③
TRAIN TRACKS
HAYNES ST.
④
MYRTLE AVE.
N
SIDE BRANCH - NOT SURVEYED
⑤
LEFEUVRE RD.
BRADNER RD.
TO HIGHWAY #1 (26th EXIT)
TOWNSHIPLINE RD.
* MAP NOT TO SCALE

Nathan Creek sketch map (not to scale).

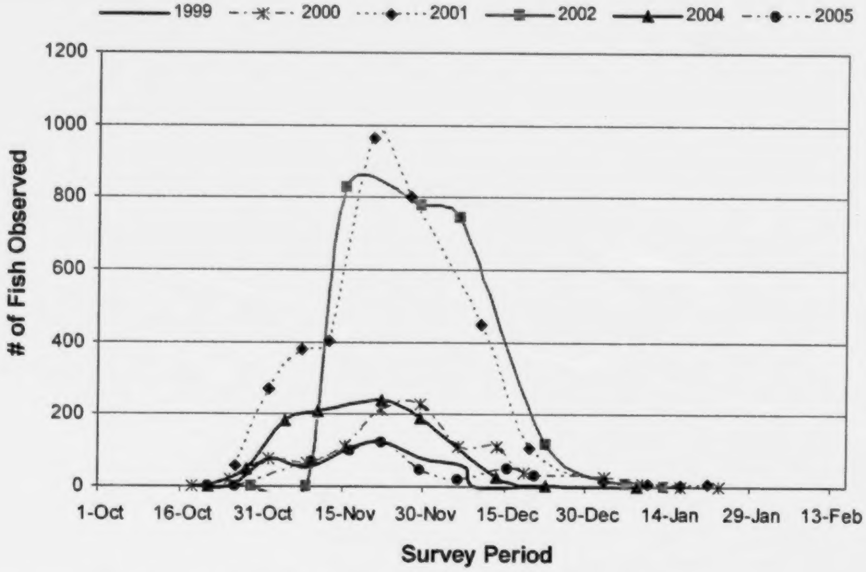
Survey Logistics: Due to the large area surveyed, four crew members are required. To access the survey area, drive east on Highway #1 (towards Abbotsford) to the 264th Street Exit; head north on 264th Street to 56th Avenue and turn right (east); follow to 272nd Street and turn left (north); follow 272nd St to 60th Avenue and turn right (east); follow to Nathan Avenue culvert crossing. To survey segments 1 and 2, two crew members walk down the access trail (at Nathan Ave. culvert crossing) to marker located approximately 500 m downstream and survey from there to the 56th Avenue bridge crossing. There is a fork in the creek immediately upstream of the Nathan Avenue culvert crossing, the west channel is surveyed. Segments 3 to 5 are accessed by driving east on 56th Avenue to creek crossing. To survey segments 3 to 5, two crew members survey from the 56th Avenue bridge crossing, south to the Townshipline Road culvert crossing.

Surveyed Spawning Area: The proportion of coho spawning area surveyed is assumed to be very good for the mainstem. However, there is a side channel (~3 km of spawning area) in segment 5 that is not surveyed and the numbers of spawning coho are unknown. The proportion of chum spawning area surveyed is assumed to be moderate to good given the unsurveyed lower areas that are channelized and dyked represent poor spawning habitat and, therefore, are assumed to have negligible numbers of spawners.

RESULTS

Observer Efficiency: Nathan Creek had an average O.E. (0.67 ± 0.11) for all segments and years assessed and was consistent among segments. High visibility was attributed to minimal surface glare (limited exposure to sunlight), limited instream cover, low flows, and optimal channel characteristics (narrow channel widths and mostly shallow water). Visibility was reduced during rain events when turbidity increased (water clarity decreased).

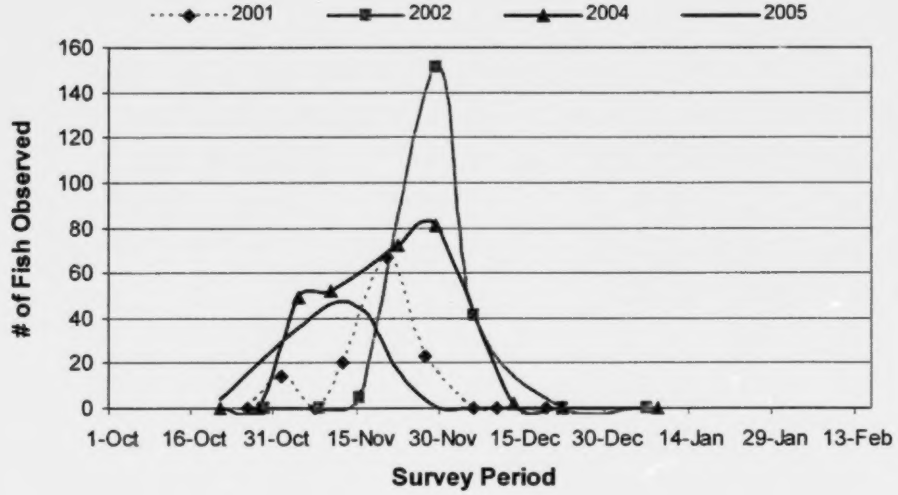
Coho Salmon: Run timing for coho was moderately variable among years assessed, beginning October 18 to November 15, peaking November 15-29, and ending December 7 to January 21. Peak visual counts also exhibited considerable variation among survey years, ranging from 124 to 966 coho. Run timing was unimodal and peak spawning activity was protracted:



Coho escapements ranged from 302-2,481 in 1999 to 2005 (R.T.: 11 days)

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	375	799	2,729	3,032	947	369
10	338	720	2,456	2,729	852	332
11	**307**	**654**	**2,233**	**2,481**	**775**	**302**
12	281	600	2,047	2,274	710	276
13	260	553	1,889	2,099	656	221

Chum Salmon: Run timing for chum was consistent among years, beginning November 1-16, peaking November 20-29, and ending November 27 to December 13. Peak visual counts, were somewhat variable among years, ranging from 67-151 chum. Run timing was unimodal:



Chum escapements ranged from 90-233 in 2001 to 2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	113	265	291	128
9	n/a	n/a	100	235	259	114
10	**n/a**	**n/a**	**90**	**212**	**233**	**102**
11	n/a	n/a	82	193	212	93
12	n/a	n/a	75	177	194	85

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.004 fish/m^2 (2005) to 0.06 fish/m^2 (2002), with an average of 0.02 fish/m^2 over 6 years. Average chum spawner density ranged from 0.005 fish/m^2 (2001) to 0.018 fish/m^2 (2004), with an average of 0.011 fish/m^2 over 4 years.

The greatest proportions of coho and chum were observed in segments 2 (average: coho 0.33, chum 0.37) and five (average: coho 0.31, chum 0.26). Both species were observed spawning throughout the entire survey area with little competition for available spawning habitat.

Spawning habitat was abundant in all five survey segments; benthic substrate was predominantly small gravel and cobbles. Instream cover was abundant and the riparian buffer was a mixed-wood forest. Habitat concerns are identified below:

	Concern	Comments
Flow/Gradient		
Spawning Substrate		
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer		
Stream bank erosion	X	many stream banks in segments 1 to 3 are steep and are eroding into the river
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

NORRISH (SUICIDE) CREEK

Watershed Code: 100-0640-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Norrish Creek is approximately 25 km long (2.1 km surveyed) and flows south from its headwaters into Nicomen Slough. The creek flows through a steep canyon in the upper 20 km, emerges from the canyon and subsequently flows into a 2.4 km long dyked channel and into a wide alluvial fan (surveyed area) with excellent gravel deposits (Schubert 1982). Its major tributaries include Inch and Worth Creek. The surveyed segments flow through a floodplain mixed deciduous/coniferous forest

METHODS

Study Area: The surveyed area extends from Norrish Creek's confluence with Nicomen Slough, northwest, to the bridge crossing at Hawkins-Pickle Road. Norrish Creek runs through a very wide (> 150 m) scour path and the wetted channel changes from year to year; consequently, segment characteristics and distances change depending on the flow pattern. This creek was surveyed for coho and chum from 2001 to 2004 (excluding 2003). In 2001 there were two survey segments, encompassing the area from the Hawkins-Pickle Road bridge to a marker ~ 700 m downstream. In 2002, two additional segments were added, encompassing the section of Norrish Creek from the Hawkins-Pickle Road bridge to the mouth at Nicomen Slough. In 2004, segment 1 was further divided into sub-sections A, B and C to accommodate for channel braids that had formed from a previous high water event. Upper and lower survey boundaries were similar enough (channel path alters from year to year) from 2001 to 2004 to show comparative spawner distribution. Additionally, during higher flows (2004), small side channels were created. These channels were assessed and observations were recorded in the associated segments. The surveyed segments are as follows:

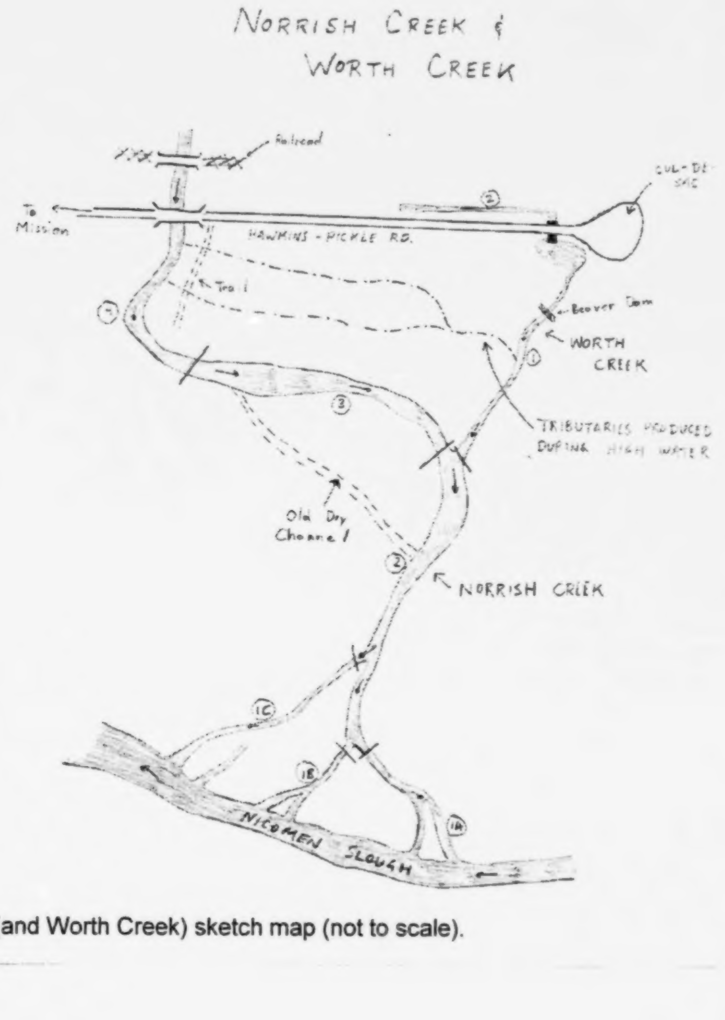
Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1A	confluence w/ Nicomen Slough	49°10'25" N 122°8'6" W	confluence w/ Norrish mainstem	49°10'23" N 122°8'18" W	140	5-10
1B	confluence w/ Nicomen Slough	49°10'16" N 122°8'14" W	confluence w/ Norrish mainstem	49°10'23" N 122°8'18" W	165	5-10
1C	confluence w/ Nicomen Slough	49°10'11" N 122°8'19" W	confluence w/ Norrish mainstem	49°10'21" N 122°8'22" W	445	15-20
2	1A/1B split	49°10'23" N 122°8'18" W	confluence w/ Worth Creek	49°10'35" N 122°8'42" W	570	20-30
3	confluence w/ Worth Creek	49°10'35" N 122°8'42" W	last bend before bridge	49°10'33" N 122°8'42" W	325	20-30
4	last bend before bridge	49°10'33" N 122°8'42" W	Hawkins Pickle Rd. bridge crossing	49°10'34" N 122°8'50" W	410	15-20

Segment 1A extends 140 m from Norrish Creek's confluence with Nicomen Slough, north (upstream) to the 1A/1B split: it is the east branch running through the alluvial fan at the mouth of Norrish Creek. Spawning habitat is excellent; benthic substrate includes gravels and cobbles. There is limited instream cover with few cutbanks and instream woody debris. The gradient and flows are moderate. There is a limited riparian buffer of tall grasses.

Segment 1B extends 165 m from Norrish Creek's confluence with Nicomen Slough, north (upstream) to the 1A/1B split: it is the center branch running through the alluvial fan at the mouth of Norrish Creek. In this segment there is abundant spawning habitat; benthic substrate includes gravel and cobble. There is no available cover, with the exception of two deep pools. The gradient and flows are moderate. There is a limited riparian buffer of tall grasses.

Segment 1C extends 445 m from Norrish Creek's confluence with Nicomen Slough, northeast (upstream) to its reconnection to the Norrish Creek mainstem: it is the west branch running through the alluvial fan at the mouth of Norrish Creek. In this segment there is abundant spawning habitat; benthic substrate includes gravel and cobble. Instream cover is limited and includes streamside vegetation and instream woody debris. The gradient of this segment is low and the flow is moderate. There is a riparian buffer of tall grasses and mixed herbaceous shrubs on the north side of this segment.

Segment 2 extends 570 m from the split of segments 1A and 1B, north (upstream) to the confluence with Worth Creek. Spawning habitat is abundant throughout this segment; benthic substrate includes small loose gravel, sand, cobble, and boulders. There is minimal instream cover from deep pools and instream woody debris. The gradient of this segment is moderate and flows can be swift, particularly during heavy rainfall. There is a riparian buffer of tall grasses and mixed herbaceous shrubs on both banks of this segment.


NORRISH CREEK &
WORTH CREEK
Railroad
CUL-DE-SAC
②
To Mission
HAWKINS - PICKLE RD.
Trail
④
Beaver Dam
WORTH CREEK
①
③
TRIBUTARIES PRODUCED DURING HIGH WATER
Old Dry Channel
②
NORRISH CREEK
1C
1B
1A
NICOMEN SLOUGH

Norrish Creek (and Worth Creek) sketch map (not to scale).

Segment 3 extends 325 m from the confluence with Worth Creek, northwest (upstream) to the marker at the last visible bend before the Hawkins-Pickle Road bridge crossing. Spawning habitat is abundant; benthic substrate includes loose gravel and cobbles. Deep pools provide the only form of cover in this segment. The gradient of this segment is steep, the channel is wide (~20-25 m), and flows can be fast during heavy rain events. A large riparian buffer of mixed forest is present on the north bank, while the south bank provides a small buffer of tall grasses and herbaceous shrubs.

Segment 4 extends 410 m from the marker at the last visible bend in the channel, north (upstream) to the Hawkins-Pickle Road bridge crossing. Spawning habitat is abundant; benthic substrate includes loose small gravel and cobbles. There is adequate cover that includes pools, overhanging vegetation, and some cutbanks. The gradient and flows of this segment are moderate. A riparian buffer of mixed forest occurs on both banks.

Survey Logistics: Two crew members are required to survey Norrish Creek. Due to its close proximity with Worth creek, these two systems are generally surveyed on the same day. To access the survey area, the crew drive east on the Lougheed Highway (#7) (Mission) and continues east through a 3-way intersection to Hawkins-Pickle Road. They follow Hawkins-Pickle Road, cross over the train tracks (south), and park the vehicle at the Norrish Creek bridge crossing. Both crew members walk south on a foot trail (running parallel to Norrish Creek) and then down the bank of the channel to the mouth (Nicomen Slough). To survey segments 1A, 1B, and 1C, the two crew members split up; one crew member surveys 1A and 1B (walking upstream in 1A and then downstream in 1B) while the other crew member surveys 1C (starting at the mouth and walking upstream to Norrish mainstem). Once complete, the two crew members survey segments 2 to 4 from the junction of segments 1A and 1B, upstream to the bridge crossing at Hawkins-Pickle Road. Due to the width and the number of fish present in these segments, the surveyors walk side-by-side in the middle of the channel, counting on one side only (right or left). These two numbers are then added together to form a total segment visual count.

NOTE: *This creek may pose a threat to the safety of a surveyor from increased water levels during rainfall events.*

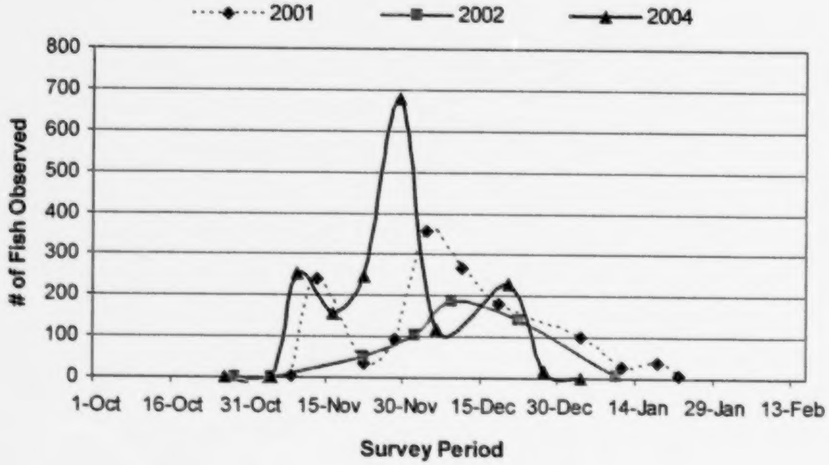
Proportion of Spawning Area: The proportion of coho spawning area covered by the survey is assumed to be good to very good. The proportion of chum spawning area covered by the survey is assumed to be very good to excellent.

RESULTS

Observer Efficiency: Norrish Creek had a low average O.E. (0.60 ± 0.11) for all segments and years assessed. Observer efficiency was slightly higher in segment 1 (average: 0.66 ± 0.15) versus segment 2 (average: 0.61 ± 0.14), 3 (average: 0.58 ± 0.19), and 4 (average: 0.64 ± 0.14). High visibility in segment 1 can be attributed to excellent water clarity, limited instream cover, and ideal channel characteristics. This segment is comprised of three sub-segments, all of which are shallow, narrow, and have extremely clear water. Visibility in segments 2 to 4 are affected by their widths and surface glare during morning hours. These segments also have deep pools, large numbers of holding and spawning fish (thousands), and significant interspecies mixing.

During rain events, Norrish Creek's width and depth increase dramatically. Since this system responds quickly to rain events, it is frequently challenging to count chum or coho. Visibility is particularly compromised in segments 2 and 3 due to the large numbers of fish present, multi-species stacking, wide channel widths, and extreme surface glare. Since assessment of observer efficiencies were challenging for these segments in 2004 and new surveyors assigned extremely low observer efficiencies, average observer efficiencies for each segment were applied to 2004 data.

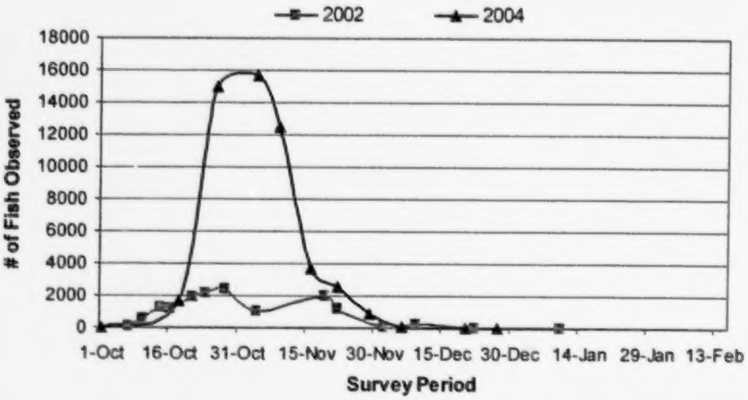
Coho Salmon: Run timing for coho was moderately variable among years, beginning November 8-22, peaking November 24 to December 14 and ending December 27 to January 22. Peak visual counts were variable among survey years, ranging from 188 to 680 coho:



Coho escapements were moderately variable, ranging from 502-1,151 in 2001 to 2004 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	1,158	614	1,407	n/a
10	n/a	n/a	1,042	553	1,266	n/a
11	**n/a**	**n/a**	**947**	**502**	**1,151**	**n/a**
12	n/a	n/a	868	460	1,055	n/a
13	n/a	n/a	802	425	974	n/a

Chum Salmon: Run timing for chum was consistent among years, beginning October 1-7, peaking October 28 to November 4, and ending December 6-22. Peak visual counts were variable among survey years, ranging from 2,422-15,715 chum:



Chum escapements were moderately variable, ranging from 7,804-37,998 in 2002 and 2004 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	n/a	9,754	47,496	n/a
9	n/a	n/a	n/a	8,671	42,220	n/a
10	**n/a**	**n/a**	**n/a**	**7,804**	**37,998**	**n/a**
11	n/a	n/a	n/a	7,094	34,544	n/a
12	n/a	n/a	n/a	6,503	31,165	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.006 fish/m^2 (2004) to 0.012 fish/m^2 (2001), with an average of 0.008 fish/m^2 over 3 years. Average chum spawner density ranged from 0.046 fish/m^2 (2002) to 0.373 fish/m^2 (2004), with an average of 0.209 fish/m^2 over 2 years.

The greatest proportion of coho were observed in segments 2 (average: 0.45), 3 (average: 0.30), and 4 (average: 0.25). The proportion of coho in segment 1 was relatively low (0.19) since this segment was shallow with little instream cover and, therefore coho migrated through this area rapidly.

Chum spawning was observed throughout all survey segments and spawning habitat was not observed to be limiting; in 2004, however, redds overlapped somewhat in segments 3 and 4. Chum spawners were most abundant in segment 3 (average: 0.33), followed by segments 2 and 4 (average: 0.24), with spawning densities highest in segment 1.

Spawning habitat for coho and chum is abundant throughout all of the survey segments; benthic substrate was predominantly larger gravel and cobbles. Instream cover was severely restricted as all segments were highly exposed; cover habitat was limited to sporadic deep pools. There was an excellent riparian buffer throughout the survey area.

	Concern	Comments
Flow/Gradient	X	segment 2 has fast flows
Spawning Substrate		
Instream Cover	X	limited instream cover
Adjacent Land Use		
Residential		
Agricultural	X	segment 2 is adjacent to agricultural land
Roads		
Riparian Buffer		
Stream bank erosion	X	segment 2 stream banks are very unstable
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous		
Hatchery supplemented	Yes	coho are stocked by the Inch Creek Hatchery

Number and average weight of coho and chum juveniles stocked into Norrish Creek by the Inch Creek hatchery from 1999 to 2005 is presented below:

Species	Release Year	# Released	Avg. Weight (g)	Stage Released
COHO	1999	59,381	23.3	Smolts
	2000	159,501	20.4	Smolts
	2001	165,401	19.8	Smolts
	2002	167,878	20.1	Smolts
	2003	81,794	19.8	Smolts
	2004	152,741	19.3	Smolts
	2005	149,965	21	Smolts
CHUM	*not enhanced*			

NORTH ALOUETTE RIVER

Watershed Code: 100-0267-060-064-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

North Alouette River is approximately 25 km long (~ 2.2 km surveyed) and flows from its headwaters southwest into the South Alouette River and ultimately into the Chatham reach of the lower Pitt River. The upper 15 km of the river flow through a densely wooded canyon, the lower 10 km flow through a low-lying plain (survey area) becoming slough-like in the lower 6 km (Schubert 1982). The major tributaries are Spring and Jacob Creek.

METHODS

Study Area: The survey area extends from the 132nd Avenue bridge crossing, northeast to the passable falls (and major fork in the river) 600 m upstream of the 232nd Street bridge crossing. This creek was surveyed for coho and chum in 2001 and 2004. In 2004, an additional survey segment was added (600 m) to incorporate for observed coho and chum spawning activity. The survey segments are as follows:

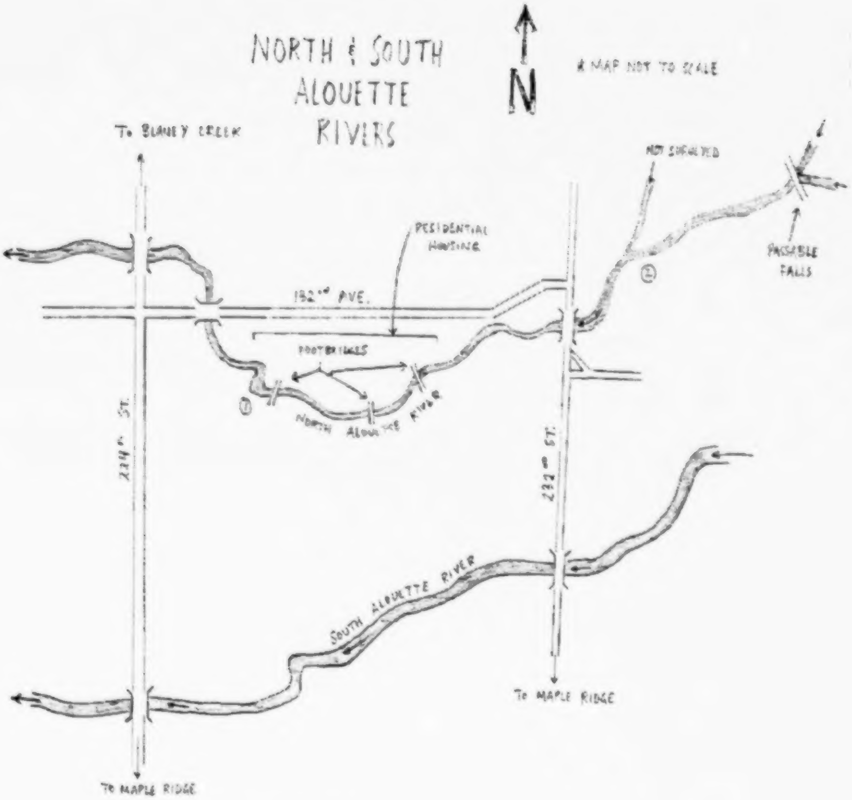
Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	132 Ave bridge crossing	49°14'31" N 122°35'45" W	232 St bridge crossing	49°14'34" N 122°34'47" W	1600	45-60
2	232 St bridge crossing	49°14'34" N 122°34'47" W	falls, fork in creek	49°14'52" N 122°34'5" W	600	25-35

Segment 1 extends 1.6 km from the 132nd Ave. bridge crossing, east (upstream) to the 232nd Street bridge crossing. This segment flows through a highly developed residential area. Spawning habitat is abundant; benthic substrate includes gravel deposits interspersed with large cobbles and boulders. There is a limited amount of instream cover available from deep pools. The gradient of the segment is moderate and steepens in the upper sections; flow rates coincide with gradient (larger gradients result in greater flows) and can become quite fast. Since the lower 900 m of this segment is adjacent to residential properties, there is no riparian buffer. In the upper sections of this segment there is a small riparian buffer of mixed deciduous forest.

Segment 2 extends 600 m from the 232nd Street bridge crossing, northeast (upstream) to the passable falls and significant fork in the channel. Spawning habitat is limited in this segment; benthic substrate includes larger cobbles and boulders. Instream cover is moderate and includes boulder pools, cutbanks, and overhanging streamside vegetation. The gradient of this segment is steep and flows are moderate, but can be flashy during periods of increased rainfall. There is a limited riparian buffer of small shrubs and deciduous forest along most of this segment.

Survey Logistics: A minimum of two crew members are required to survey the North Alouette River. To access the survey area, the crew drive north on 224th Street (Maple Ridge) and turn right (east) onto 132nd Avenue. They follow 132nd Ave. east to the bridge crossing and park the vehicle. To survey segment 1, one crew member surveys from the 132nd Ave. bridge crossing to the 232nd Street bridge crossing. To survey segment 2, the second crew member surveys from the 232nd Street bridge crossing to the passable falls, exiting the segment and walking downstream to the vehicle.

***NOTE:** Since segments of this river (particularly segment 1) flow through residential properties, there is frequent concern among residents regarding the presence of surveyors and their impacts on spawning habitat.*


NORTH & SOUTH
ALOUETTE
RIVERS
N
* MAP NOT TO SCALE
To BLANEY CREEK
NOT SURVEYED
RESIDENTIAL
HOUSING
PASSABLE
FALLS
132nd AVE.
FOOTBRIDGES
①
②
NORTH ALOUETTE RIVER
224th ST.
232nd ST.
SOUTH ALOUETTE RIVER
To MAPLE RIDGE
TO MAPLE RIDGE

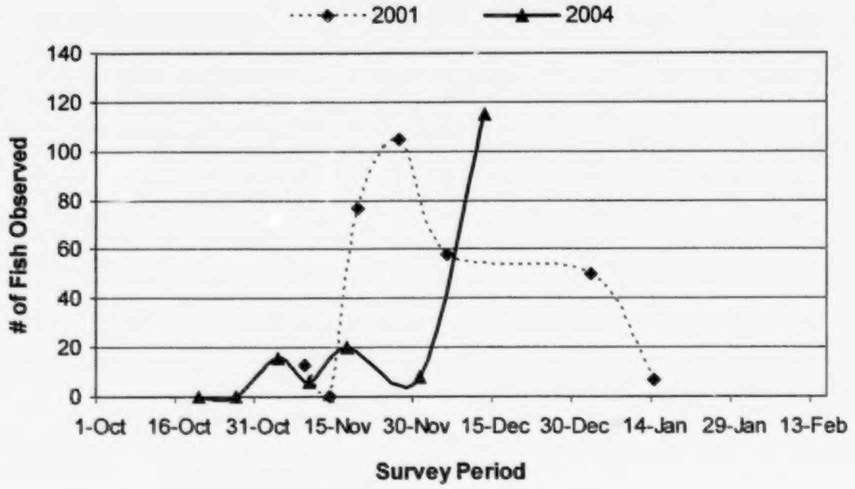
North Alouette River sketch map (not to scale).

Proportion of Spawning Area: There are unsurveyed areas both below and above the survey area that may contain spawning areas. For this reason, the coverage of coho and chum, is assumed to be moderate to good.

RESULTS

Observer Efficiency: The North Alouette River had a low average O.E. (0.56 ± 0.15) for all segments and years assessed. Observer efficiency was similar among segments 1 (0.69 ± 0.13) and 2 (0.62 ± 0.17) in 2004. Visibility in segment 1 was reduced by surface glare (exposure to sunlight), substrate colour (very dark), and channel characteristics (wide channel widths and deep pools). Visibility in segment 2 was reduced by surface glare (exposure to sunlight), substrate size (large boulders create downstream pools with turbulent water), and channel characteristics (wide channel widths).

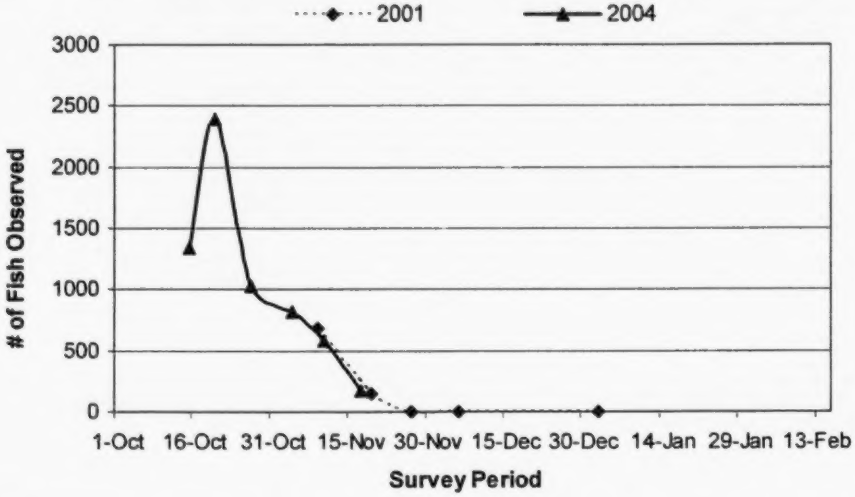
Coho Salmon: Initial run timing for coho was consistent among years, beginning November 4-9. In 2001, coho run timing peaked on November 30 and ended on January 14. Based on 2001 data, run timing was unimodal.



Coho escapements ranged from 39-317 in 2001 and 2004 (R.T.: 11 days). The 2004 results represent minimum escapements since the entire run was not assessed.

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	388	n/a	48	n/a
10	n/a	n/a	349	n/a	43	n/a
11	**n/a**	**n/a**	**317**	**n/a**	**39**	**n/a**
12	n/a	n/a	291	n/a	36	n/a
13	n/a	n/a	269	n/a	33	n/a

Chum Salmon: For both years surveyed (2001 and 2004), initial visual assessments commenced during the peak of chum spawning and significant portions of the run were missed. Due to the incomplete data set, trends over time cannot be subjectively assessed.



Chum escapements ranged from 271-4,000 in 2001 and 2004 (R.T.: 10 days): for both survey years the entire run was not assessed so these estimates may not truly reflect abundance.

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	339	n/a	5,000	n/a
9	n/a	n/a	302	n/a	4,444	n/a
10	**n/a**	**n/a**	**271**	**n/a**	**4,000**	**n/a**
11	n/a	n/a	247	n/a	3,636	n/a
12	n/a	n/a	226	n/a	3,333	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.001 fish/m^2 (2004) to 0.003 fish/m^2 (2001), with an average of 0.002 fish/m^2 over 2 years. Chum spawner density was only assessed for one year, averaging 0.038 fish/m^2 (2004).

Based on 2004 data, the highest proportion of coho (0.95) and greatest densities (0.002 fish/m^2) were observed in segment 1. No competition for available spawning habitat was observed. Very few coho were observed spawning in segment 2.

The majority of chum spawning activity also took place in segment 1 with little observed competition for available space (proportion: 0.92 and spawner density: 0.047 fish/m^2). Chum spawning in segment 2 was limited to a single gravel bar near the upstream portion of the segment.

Spawning habitat was abundant in segment 1; benthic substrate was predominantly small gravel. Spawning habitat in segment 2 was limited to the upper sections and along low-velocity channel margins. In segment 2, substrate was predominantly larger cobbles and boulders with intermittent gravel deposits. Instream cover is minimal in both segments; cover habitat is limited to sporadic deep pools. The majority of the survey area flows through residential development so riparian buffers are negligible.

	Concern	Comments
Flow/Gradient	X	upper sections of segment 1 and segment 2 are steep and flows can be fast
Spawning Substrate	X	segment 2 has limited substrate (cobbles and boulders)
Instream Cover		
Adjacent Land Use		
Residential	X	segment 1 flows through residential property
Agricultural		
Roads		
Riparian Buffer	X	segment 1 has a limited riparian buffer since it flows through residential property; highly exposed
Stream bank erosion		
Garbage		
Spawning disturbance	X	landowners and household pets have unrestricted access to spawning habitat
Beaver activity		
Miscellaneous		
Hatchery supplemented	Yes	stocked for coho or chum by the ALLCO hatchery

Number and average weight of coho and chum juveniles stocked in the Alouette River by the ALLCO Hatchery from 1999 to 2004.

Species	Release Year	# Released	Avg. Weight (g)	Stage Released
COHO	1999	20,120	23	Smolts
	2000	80,000	1	Fed Spring
		9,240	25.4	Smolts
	2001	56,850	1.8	Fed Spring
		70,941	21.2	Smolts
	2002	96,225	2.2	Fed Spring
		35,717	23.6	Smolts
	2003	85,000	2	Fed Spring
		101,625	20	Smolts
	2004	70,000	2.5	Fed Spring
	2005	64,340	23	Smolts
CHUM	1999	1,676,000	0.75	Fed FW
	2000	661,000	1	Fed FW
	2001	855,904	1	Fed FW
	2002	134,979	0.89	Fed FW
	2003	not enhanced		
	2004	not enhanced		
	2005	200,000	1.3	Fed FW

POST CREEK

Watershed Code: 100-0657-097-619-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Post Creek is approximately 4.8 km long (~ 1.8 km surveyed) and flows southwest into the north side of the Chilliwack River (approximately 2 km downstream of Chilliwack Lake). There are no major tributaries and the creek primarily flows through a dense forested area with some residential development occurring near its confluence with the Chilliwack River.

METHODS

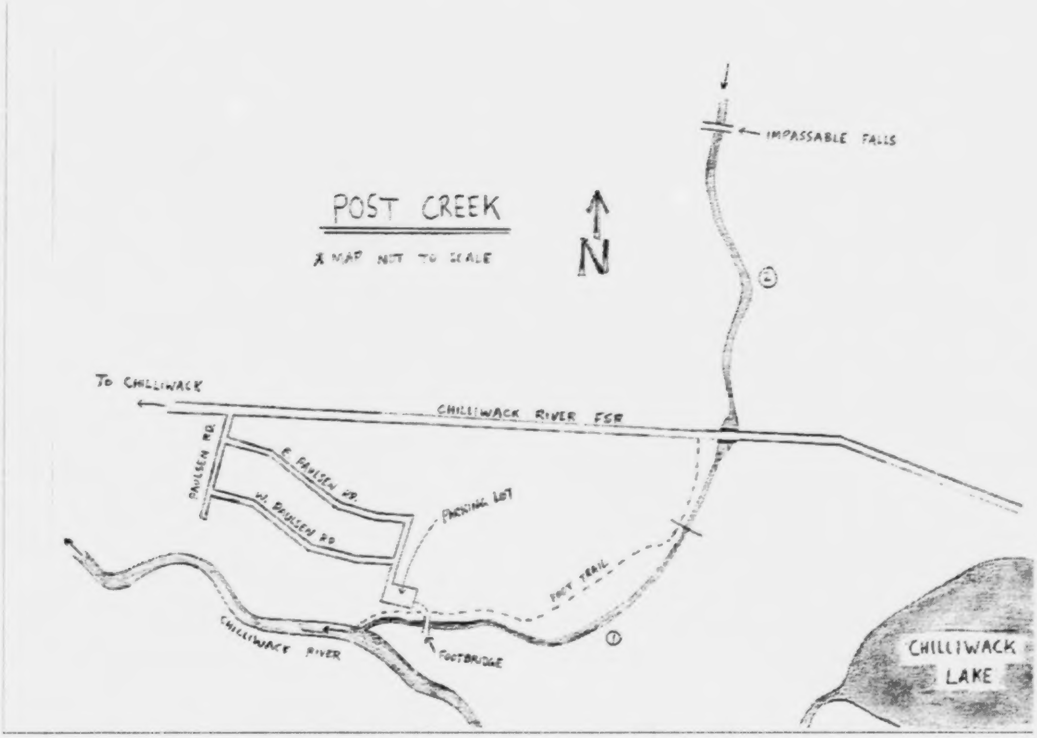
Study Area: The surveyed area extends from Post Creek's confluence with the Chilliwack River, northeast to the 1,000 m marker, and from its culvert crossing at Chilliwack Lake Road, north to the impassable falls at the 2.7 km mark. This creek was surveyed for coho from 1999 to 2005 (excluding 2003). For 1999 to 2001, there were two survey segments; 1,000 m (mouth to marker) and 790 m (road to falls) respectively. In 2002, these segments were divided in half to specify spawning distribution in the survey area, creating a total of four survey segments. In 2004, the lower 1,000 m was again divided into four 250 m segments for a total of six survey segments. Upper and lower survey boundaries were identical for all five survey years. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	mouth (into Chilliwack River)	49°5'30" N 121°28'47" W	1000 m marker	49°5'43" N 121°27'47" W	1000	45-60
2	Chilliwack Lake Road culvert crossing	49°5'53" N 121°27'39" W	falls	49°6'19" N 121°27'35" W	790	30-45

Segment 1 extends 1,000 m from Post Creek's confluence with the Chilliwack River, northeast (upstream) to the 1,000 m marker. Spawning habitat is abundant; the benthic substrate includes small-sized gravel interspersed with clusters of boulder. Instream cover is also abundant and includes overhanging vegetation, instream woody debris, and dense canopy closure. The gradient of the segment is moderate and flows are moderate. There is an excellent riparian buffer of undisturbed forest on either bank.

Segment 2 extends 790 m from the culvert crossing on Chilliwack Lake Road, north (upstream) to the impassable falls. Spawning habitat is abundant; benthic substrate is similar to segment 1, with boulders becoming more abundant. Instream cover is excellent and includes deep pools, overhanging streamside vegetation, and canopy closure. The gradient increases in the segment and flow can become rapid. There is a riparian buffer of mixed-deciduous forest.

Survey Logistics: Two crew members are required to survey Post Creek. To access the survey area, the crew drive east on Chilliwack Lake Road and turn right (south) on Paulsen Road. They follow Paulsen Road south and turn left (east) on West Paulsen Road and park the vehicle at the end of West Paulsen Road. To survey segment 1, both crew members follow the access trail to Post Creek's confluence with the Chilliwack River and survey from the mouth to the 1000 m marker. They return to the vehicle using the access trail that parallels the creek. To survey segment 2, both crew members drive to the park entrance and survey from the culvert crossing to the falls and return to the vehicle via the trail.


POST CREEK
* MAP NOT TO SCALE
N
IMPASSABLE FALLS
②
TO CHILLIWACK
CHILLIWACK RIVER FSR
PAULSEN RD.
E. PAULSEN RD.
W. PAULSEN RD.
PARKING LOT
FOOT TRAIL
①
CHILLIWACK RIVER
FOOTBRIDGE
CHILLIWACK LAKE

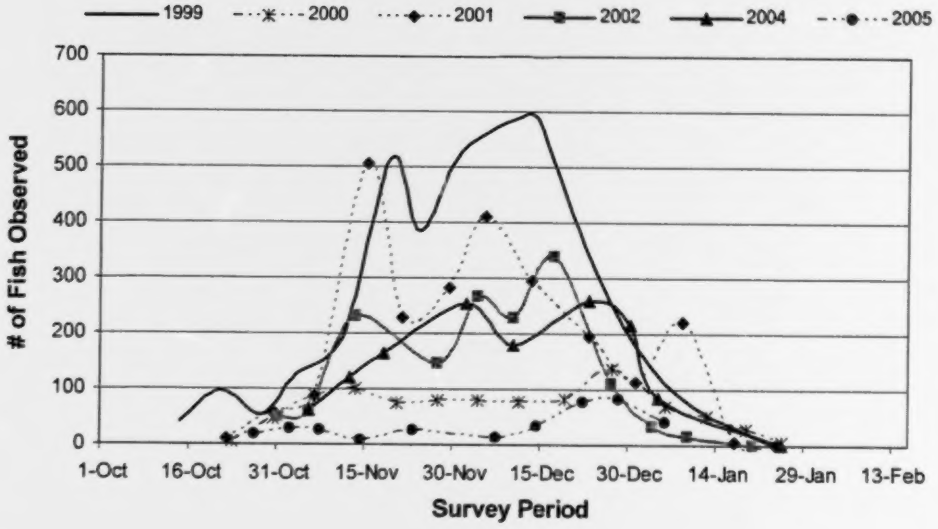
Post Creek sketch map (not to scale).

Proportion of Spawning Area: The proportion of coho spawning area covered by the survey is assumed to be good to very good. There have no chum observed during this survey.

RESULTS

Observer Efficiency: Post Creek had a moderate average O.E. (0.68 ± 0.12) for all segments and years assessed and was consistent among segments. High visibility in the segments can be attributed to excellent water clarity (clear water), minimal surface glare (limited exposure to sunlight), substrate colour (high contrast among substrate and spawners), and low flows. Visibility was reduced due to instream cover (abundant cutbank and instream woody debris).

Coho Salmon: Run timing for coho was consistent among years, beginning October 14-31, peaking November 15 to December 28 and ending January 4-25. Run sizes were variable among survey years; peak counts ranged from 81-594 coho. Run timing was generally bimodal with two or more peak spawning periods:



Coho escapements ranged from 195-2,400 in 1999 to 2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	2,933	753	2,069	1,329	1,475	238
10	2,640	678	1,862	1,196	1,328	214
11	**2,400**	**616**	**1,693**	**1,088**	**1,207**	**195**
12	2,200	565	1,552	997	1,106	178
13	2,031	522	1,433	920	1,021	165

Chum Salmon: For all years surveyed (1999 - 2005), presence of chum within the survey area boundaries was not observed.

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.007 fish/m^2 (2005) to 0.046 fish/m^2 (1999), with an average of 0.026 fish/m^2 over 6 years. Coho spawning was observed from the mouth of Post Creek (confluence with Chilliwack River) to the falls. The entire survey area was heavily used by coho spawners with the proportion of fish observed relatively equal among both segment 1 (average: 0.52) and segment 2 (average: 0.48). Spawner densities, however, were greater in segment 2 (0.036 fish/m^2) compared to segment 1 (0.025 fish/m^2). Spawning habitat did not appear to be limiting; no overlapping redds were observed. Chum were not observed in this creek.

Spawning habitat was abundant in both segments; benthic substrate was predominantly gravel. The instream cover included large woody debris, cutbanks, and streamside vegetation and the riparian buffer was a mixed-wood forest.

	Concern	Comments
Flow/Gradient	X	segment 2 has a steeper gradient and flows can be rapid
Spawning Substrate		
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer		
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous		
Hatchery supplemented	**No**	not stocked for coho or chum; although not observed some straying of stocked coho or chum from the Chilliwack River might occur

SALMON RIVER

Watershed Code: 100-0388-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

The Salmon River is approximately 33 km long (~ 10 km surveyed) and flows north into the south side of the Fraser River at Fort Langley. Including its major tributary, Coghlan Creek, the system drains a watershed of 85 km^2 (Schubert 1982). The upper reaches are marshy and flow through shallow valleys; the middle sections flow through gently sloping terrain in a meandering protected channel with excellent gravel deposits; the lower 10 km becomes slow and slough-like (Schubert 1982). The Salmon River is an indicator system for coho salmon and a counting fence currently operates on this system to enumerate and obtain biological information from migrating adults and smolts and to apply coded-wire tags to assess exploitation rates.

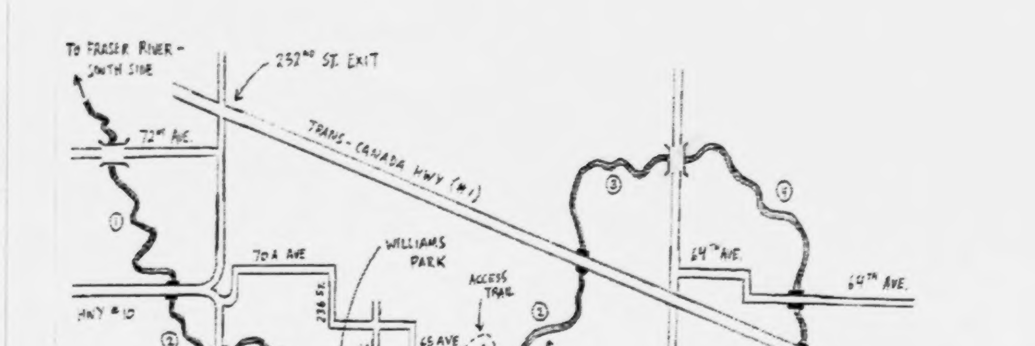
METHODS

Study Area: The surveyed area extends from the 72nd Avenue bridge crossing, southeast to the Hitching Post Crescent culvert crossing. This river was surveyed for coho from 1999 to 2004 (excluding 2003) and for chum in 2002 and 2004. From 1999 to 2001, there were a total of six survey segments. In 2002, two segments (1000 m) were added (72nd Avenue to Highway #10). Additionally, all segments from 2001 that exceeded 1000 m were divided into 500 m segments for a total of twenty survey segments in 2002. In 2004, there were ten survey segments; the upper and lower boundaries of the survey area were identical in 2002 and 2004. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	72 Ave bridge crossing	49°7'50" N 122°35'40" W	Highway #10 culvert crossing	49°7'47" N 122°35'15" W	1000	15-20
2	Highway #10 culvert crossing	49°7'47" N 122°35'15" W	232 St culvert crossing	49°7'38" N 122°34'53" W	1000	15-20
3	232 St culvert crossing	49°7'38" N 122°34'53" W	Confluence w/ Coghlan Creek	49°7'19" N 122°34'7" W	1000	15-20
4-7	Confluence w/ Coghlan Creek	49°7'19" N 122°34'7" W	56 Ave bridge crossing	49°6'8" N 122°32'54" W	4000	75-90
8-10	56 Ave bridge crossing	49°6'8" N 122°32'54" W	Hitching Post Cres crossing	49°5'16" N 122°32'38" W	3000	60-90

Segment 1 extends 1,000 m from the 72nd Avenue bridge crossing, southeast (upstream) to the Highway 10 culvert crossing. Spawning habitat is marginal in the lower sections of this segment, changing to increasingly higher quality habitat in the upper sections. Benthic substrate is fines (silts and sands) in the lower sections and loosened gravel and cobbles in the upper sections. This segment has lengthy sections that are highly exposed; limited instream cover is provided by overhanging vegetation, cutbanks, instream woody debris, and deep pools. The gradient is quite low and flows are slow. There is a minimal riparian buffer of mixed deciduous trees and shrubs.

Segment 2 extends 1,000 m from the Highway 10 culvert crossing, southeast (upstream) to the 232nd Street bridge crossing. Spawning habitat is limited in the segment; benthic substrate is predominantly fines, interspersed with areas of small-sized gravel. The channel is highly exposed; instream cover is limited to a few cutbanks, deep pools, and overhanging vegetation. The gradient is gradual and flows are slow. There is a minimal riparian buffer of mixed deciduous trees and shrubs.


TO FRASER RIVER - SOUTH SIDE
232ND ST. EXIT
72ND AVE.
TRANS-CANADA HWY (#1)
WILLIAMS PARK
70 A AVE
236 ST.
238 ST.
HWY #10
ACCESS TRAIL
65 AVE
COGHLAN CREEK
64TH AVE.
SALMON RIVER
248TH ST.
56TH AVE.
UNION CR.
232ND ST.
240TH ST.
48TH AVE.
HITCHING POST CRESCENT
SALMON RIVER & COGHLAN CREEK
N
* MAP NOT TO SCALE
①
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Salmon River (and Coghlan Creek) sketch map (not to scale).

Segment 3 extends 1,000 m from the 232nd Street bridge crossing, southeast (upstream) to the confluence with Coghlan Creek in Williams Park. There is abundant spawning habitat throughout the segment; benthic substrate is predominantly small-sized gravel and cobbles, interspersed with large boulders and fines. A large portion of this segment is exposed; instream cover is limited to overhanging streamside vegetation and deep pools. The gradient increases in this segment, although flows remain slow. Portions of the segment flow through residential areas and exhibit no riparian buffer; natural sections of the segment have a minimal riparian buffer of mixed deciduous trees and shrubs.

Segments 4-7 extend 4,000 m from the Salmon River's confluence with Coghlan Creek in Williams Park, southeast (upstream) to the 56th Avenue bridge crossing. There is excellent spawning habitat in these segments; benthic substrate is predominantly gravel interspersed with large cobbles and boulders. Instream cover is abundant in this segment and includes deep pools, overhanging vegetation, instream woody debris, and cutbanks. The gradient is gradual and flows are moderate. These segments flow through a relatively wild gulley and have a considerable riparian buffer of mixed deciduous forest.

Segments 8-10 extend 3,000 m from the 56th Avenue bridge crossing, south (upstream) to the Hitching Post Crescent culvert crossing. Spawning habitat in the lower segments is abundant and in the upper segments is limited; bottom substrate is composed of small loosened gravel mixed with fines (sands and clay). Instream cover is abundant and includes instream woody debris and overhanging streamside vegetation. The gradient is gradual and flows are moderate. The upper segments flow through agricultural areas and, as a result, have no riparian buffer. The lower segments flow through loosely developed residential areas and have a small riparian buffer of mixed deciduous trees and shrubs.

NOTE: *There are several tributaries that flow into the surveyed sections of the Salmon River (primarily segments 8 and 9). These tributaries are visually assessed during peak coho and chum spawning.*

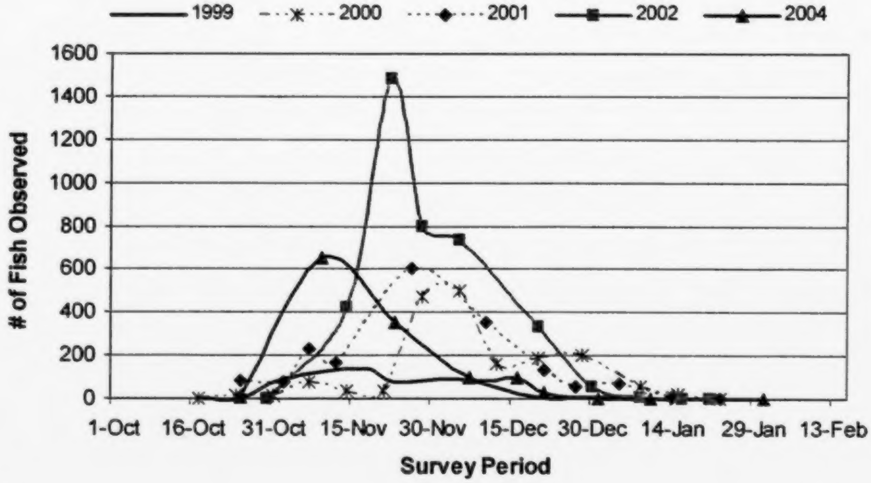
Survey Logistics: Four crew members are required to survey the Salmon River. Due to its close proximity with Coghlan Creek, these two systems are generally surveyed on the same day. To access the survey area the crew drive east on Highway #1 (towards Abbotsford) and turn off the highway at the 232nd Street Exit. They follow 232nd Street south, and turn right onto 72nd Avenue and follow this street until they reach the bridge crossing. To survey segments 1 to 3, two crew members survey from the 72nd Avenue bridge crossing to the Salmon River's confluence with Coghlan Creek in Williams Park. To access segment 4, two crew members drive south on 232nd Street and turn left (east) onto 70A Avenue and follow this street and turn right on 238th Street. The crew enter Williams Park and park their vehicle. To survey segments 4 to 10, the crew follow the stairs down to the Salmon River's confluence with Coghlan Creek. Two crew members survey from the confluence, upstream to the Hitching Post Crescent culvert crossing.

Proportion of Spawning Area: The proportion of spawning area covered by the survey, for both coho and chum, is assumed to be good to very good.

RESULTS

Observer Efficiency: Salmon River had a low average O.E. (0.57 ± 0.14) for all segments and years assessed. Observer efficiency was lowest in segment 1 (average: 0.36 ± 0.18) and relatively uniform throughout segments 2 (average: 0.51 ± 0.13), 3 (average: 0.55 ± 0.12), 4 (average: 0.60 ± 0.11), 5 (average: 0.61 ± 0.09), 6 (average: 0.60 ± 0.12) and 7 (average: 0.60 ± 0.12). Visibility in segment 1 was reduced by poor water clarity (considerable turbidity and siltation), surface glare (highly exposed with limited riparian buffer), instream cover (deep pools) and flow type (slough-like). In segments 2-7, visibility was reduced by poor water clarity (dark water), the presence of instream cover (deep pools, cutbanks, instream woody debris), and substrate colour (dark substrate). In these segments the riparian buffer was significant producing minimal surface glare.

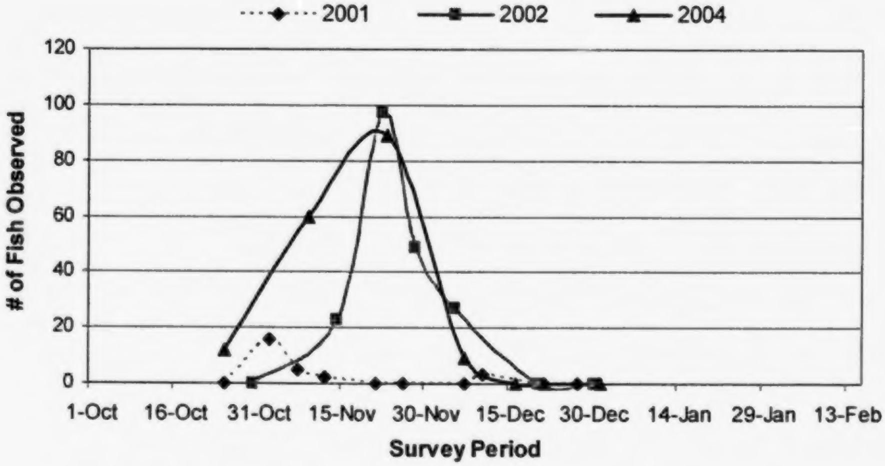
Coho Salmon: Run timing for coho was moderately variable among years, beginning October 24 to November 14, peaking November 9 to December 5 and ending January 4-21. Peak visual counts ranged from 136-1,482 coho and run timing was unimodal:



Coho escapements ranged from 1,109-3,851 coho in 1999-2005; R.T.s used to calculate annual escapements were estimated from the mark recapture-visual survey R.T. calculations from 1999-2004 (see Results section 3.5 Residence Time) and in 2005 (no mark-recapture study was conducted) using a five year average R.T. of 5 days:

1999	2000	2001	2002	2004	2005
1,109	4,019	3,076	3,851	2,631	n/a

Chum Salmon: Run timing for chum was consistent among years, beginning from October 25 to November 14, peaking November 2-23, and ending December 5-10. Peak visual counts ranged from 16-97 chum and run timing was unimodal:



Chum escapements ranged from 16-222 in 2001 to 2004 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	20	187	278	n/a
9	n/a	n/a	18	166	247	n/a
10	**n/a**	**n/a**	**16**	**150**	**222**	**n/a**
11	n/a	n/a	15	136	202	n/a
12	n/a	n/a	14	125	185	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.003 fish/m^2 (1999) to 0.018 fish/m^2 (2002), with an average of 0.008 fish/m^2 over 5 years. Average chum spawner density ranged from 0.002 fish/m^2 (2002) to 0.003 fish/m^2 (0.002), with an average of 0.002 fish/m^2 over 3 years.

Coho were observed spawning throughout the survey area. The greatest proportion of coho were counted in segments 4 (average: 0.25), 5 (average: 0.20), 6 (average: 0.20), and 7 (average: 0.18). Coho densities were similar among all segments

Most chum were observed in the lower segments, with the greatest proportion of chum observed in segments 2 and 3 (average: 0.30). Chum densities were similar among segments 1-6. No chum spawning activity was observed upstream of segment 6. Spawning habitat did not appear to be limiting for either coho or chum.

Spawning habitat was abundant in segments 3-10; substrate was predominantly small gravel and cobbles. Spawning habitat was limited in segments 1 and 2; benthic substrate was predominantly fines (sand and silt) with intermittent deposits of small gravel and cobble. There was excellent instream cover in all ten survey segments. The riparian buffer was most significant in segments 4-10; segments 1-3 flowed through residential property.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	lower sections of segment 1 and 2; 9 and 10 have limited spawning substrate (fines)
Instream Cover	X	segments 1-3 are highly exposed
Adjacent Land Use		
Residential	X	segments 1-3 flow through residential property
Agricultural	X	segments 9-10 flow through agricultural lands
Roads		
Riparian Buffer	X	segments 1-3 and 9-10 have limited riparian buffer
Stream bank erosion		
Garbage		
Spawning disturbance	X	in upper sections livestock and pets have unrestricted access to the river
Beaver activity		
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

SERPENTINE RIVER (TYNEHEAD CREEK)

Watershed Code: 900-0055-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Serpentine River is approximately 27 km long (~2.7 km surveyed) and flows southwest from its urban headwaters into Mud Bay (the inner part of Boundary Bay). The upper 5 km flows through a highly developed residential and industrial area, while the lower 22 km flows through dyked agricultural canals. The headwaters are heavily urbanized, with greater than 85% of the watershed covered by impervious materials. Here, the river is prone to flash floods during rainfall events. Its major tributaries include Mahood (Bear), Hyland, and Latimer creeks.

METHODS

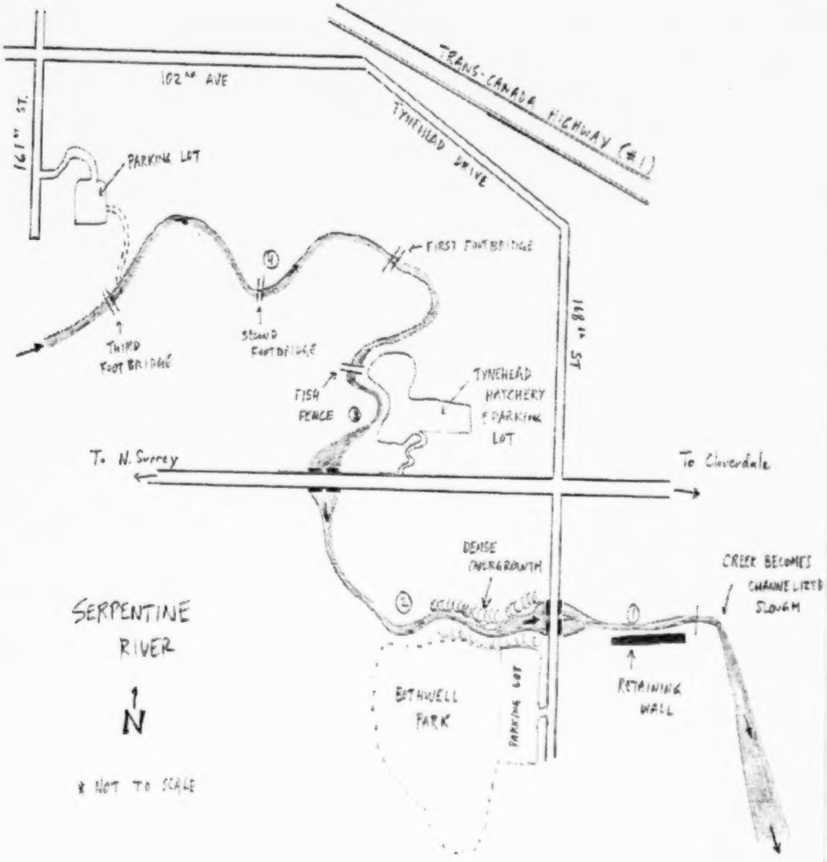
Study Area: The Serpentine River, first assessed in 2004, was surveyed from a marker 75 m downstream of the 168th Street culvert crossing, northwest to the third footbridge crossing in Tynehead Regional Park. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	marker ~75m d/s of 168 St culvert crossing	49°10'23" N 122°45'20" W	168 St culvert crossing	49°10'23" N 122°45'24" W	75	5-10
2	168 St culvert crossing	49°10'23" N 122°45'24" W	96 Ave culvert crossing	49°10'37" N 122°45'47" W	750	15-25
3	96 Ave culvert crossing	49°10'37" N 122°45'47" W	fish fence	49°10'36" N 122°45'47" W	130	5-10
4	fish fence	49°10'36" N 122°45'47" W	third foorbridge crossing	49°11'0" N 122°46'17" W	1475	45-60

Segment 1 extends 75 m from the marker located at the end of the retaining wall (river right), west (upstream) to the 168th Street culvert crossing. Spawning habitat is limited; the benthic substrate changes from sand and clay in the lower section to a small deposit of loose gravel in the upper section (just downstream of the culverts). Instream cover is excellent and includes instream vegetation and woody debris. The gradient is low and flows are usually slow. There is no riparian buffer as this segment flows through a residential area.

Segment 2 extends 750 m from the 168th Street culvert crossing, northwest (upstream) to the 96th Avenue culvert crossing. There is abundant spawning habitat throughout the segment; the benthic substrate includes loosened gravel and cobbles. Instream cover is also abundant and includes cutbanks, overhanging vegetation, instream woody debris, and deep pools. There is a very large pool located on the downstream end of the 96th Ave culvert that provides excellent cover for migrating fish. The overall gradient is moderate and flow is low. There is a wide and dense riparian buffer of mixed deciduous forest and tall grass. This segment is prone to beaver activity and dams may affect upstream fish migration.

Segment 3 extends 130 m from the 96th Avenue culvert crossing, north (upstream) to the fish fence (Figure 63). Since this channel was artificially produced specifically to provide salmon habitat, spawning habitat is abundant throughout; benthic substrate includes loose gravel and cobbles. Instream cover is also abundant and includes deep pools and streamside vegetation. The gradient is low and flow is largely regulated by the fish fence. Since this section flows through Tynehead Regional Park, the riparian buffer is a broad and dense mixed-wood forest.


TRANS-CANADA HIGHWAY (#1)
102ND AVE
161ST ST.
TYNEHEAD DRIVE
PARKING LOT
④
FIRST FOOTBRIDGE
SECOND FOOTBRIDGE
THIRD FOOT BRIDGE
168TH ST
FISH FENCE
③
TYNEHEAD HATCHERY & PARKING LOT
To N. Surrey
To Cloverdale
DENSE OVERGROWTH
CREEK BECOMES CHANNELIZED SLOUGH
②
①
SERPENTINE RIVER
N
BOTHWELL PARK
PARKING LOT
RETAINING WALL
* NOT TO SCALE

Serpentine River sketch map (not to scale).

Segment 4 extends 1,475 m from the fish fence, northwest (upstream) to the third footbridge crossing. Spawning habitat is abundant and randomly dispersed throughout this segment; the benthic substrate includes larger cobbles and boulders interspersed with small-sized gravel. Instream cover is abundant and includes cutbanks, deep pools, and streamside vegetation. The gradient increases but flows are generally moderate. Similar to segment 3, there is a riparian buffer of mixed forest on both sides as this segment flows through Tynehead Regional Park.

Survey Logistics: A minimum of two crew members are required to survey the Serpentine River. To access the survey area, the crew drive east on 96th Avenue and turn right on 168th Street. They follow 168th Street south to the culvert crossing and drop off one crew member. To survey segments 1-3, the dropped-off crew member walks downstream to the marker at the end of the retaining wall (segment 1), then surveys from there to the fish fence at Tynehead hatchery. The second crew member parks the vehicle at the Tynehead hatchery parking lot and surveys segment 4 from the fish fence to the third footbridge crossing. When the first crew member finishes segments 1-3 and arrives at the hatchery, they drive the vehicle from the hatchery parking lot east on 96th Ave. and turn north onto Tynehead Drive (168th Street). They follow 168th Street north and turn left (south) onto 161st Street and follow the signs to Tynehead Park parking lot. The trail from this parking lot leads to the third footbridge crossing.

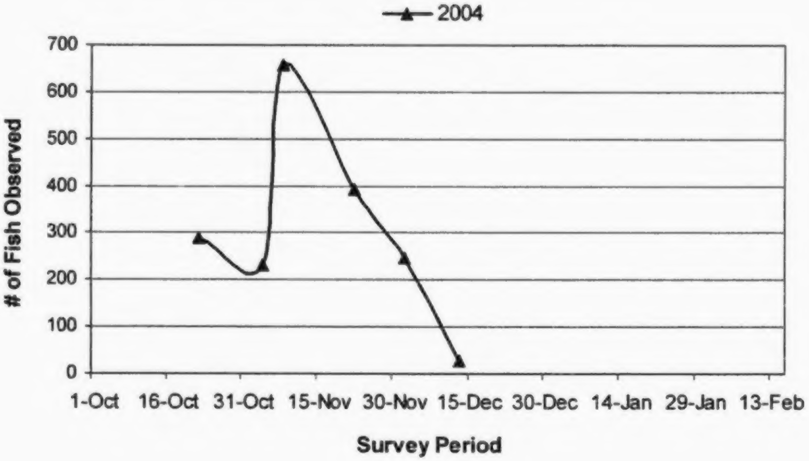
***NOTE:** Water levels in the surveyed area are extremely prone to immediate fluctuations during periods of increased rainfall. Within twenty minutes of the onset of precipitation, water levels on the Serpentine River can rise at approximately one inch every five minutes due to the large impervious area surrounding the watershed. This may pose a threat to the safety of a surveyor.*

Proportion of Spawning Area: The survey area is contained mainly in the Tynehead Regional Park. This is where most spawning is assumed to take place. The coverage of coho spawning area is assumed to be good to very good. The coverage of chum spawning area is assumed to be moderate to good.

RESULTS

Observer Efficiency: Serpentine River had a low average O.E. (0.60 ± 0.11) for all years assessed. Observer efficiency was lowest in segment 1 (0.58 ± 0.20) due to deep water and overhanging streamside vegetation. Observer efficiency in segments 2 (0.67 ± 0.10), 3 (0.75 ± 0.12) and 4 (0.68 ± 0.12) was relatively consistent and was reduced by deep pools, interspecies mixing, surface glare, and the presence of cutbanks. For the entire survey area, rain events increase turbidity and decrease O.E.

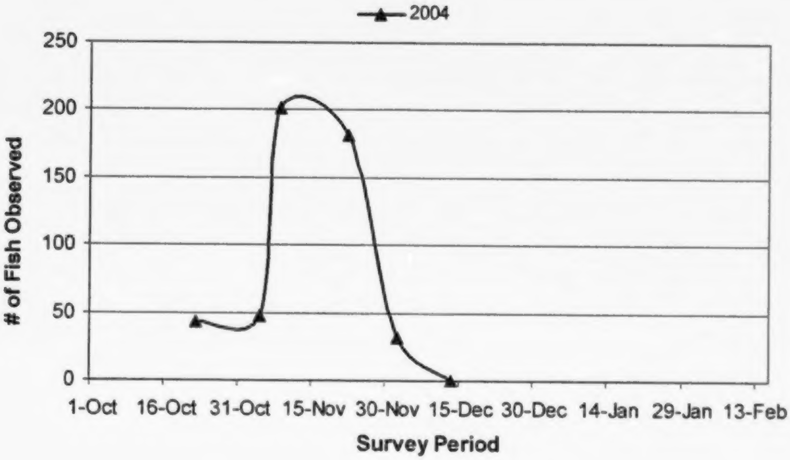
Coho Salmon: On the first survey (October 22, 2004) significant numbers of coho were already present in the system. The peak was observed on November 8, and the last coho was observed on December 13 (end of surveys), with a peak visual count of 657. Run timing appeared to be unimodal:



Coho escapement in 2004 was estimated at 1,569 (R.T.: 11 days), however, this is likely an underestimate since the start and end of the run were not observed.

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	n/a	n/a	1,919	n/a
10	n/a	n/a	n/a	n/a	1,726	n/a
11	**n/a**	**n/a**	**n/a**	**n/a**	**1,569**	**n/a**
12	n/a	n/a	n/a	n/a	1,438	n/a
13	n/a	n/a	n/a	n/a	1,328	n/a

Chum Salmon: On the first survey (October 22, 2004) significant numbers of chum were already in the system. The peak was observed on November 22, and the last chum was observed on December 2 (end of surveys), with a peak visual count of 202. Run timing was unimodal:



Chum escapement in 2004 was estimated at 501 (R.T.: 10 days), however this is likely an underestimate since the start of the run was not observed.

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	n/a	n/a	626	n/a
9	n/a	n/a	n/a	n/a	557	n/a
10	**n/a**	**n/a**	**n/a**	**n/a**	**501**	**n/a**
11	n/a	n/a	n/a	n/a	456	n/a
12	n/a	n/a	n/a	n/a	418	n/a

Spawner Densities: Spawner density was only assessed in 2004; average coho density: 0.035 fish/m^2; average chum density 0.012 fish/m^2. The greatest proportion of coho (0.56) and chum (0.71) was observed in segment 4.

In 2004, the greatest proportion of both coho and chum was observed in segment 4 (coho 0.56, chum 0.71). Spawning densities for coho and chum were greatest in segment 3 (coho: 0.066 fish/m^2, chum: 0.019 fish/m^2) followed by segment 4 (coho: 0.039 fish/m^2, chum: 0.016 fish/m^2). Spawning habitat did not appear to be limiting with very little intra- and inter-species competition observed.

Spawning habitat was limited in segment 1; benthic substrate was predominantly sand and silt and there was no riparian buffer present. In segments 2-[illegible], spawning habitat and instream cover was abundant and the riparian buffer was a mixed-wood forest.

	Concern	Comments
Flow/Gradient	X	during rainfall events water flows respond rapidly
Spawning Substrate	X	segment 1 limited substrate (sand and clay)
Instream Cover		
Adjacent Land Use		
Residential	X	segment 1 flows through residential properties
Agricultural	X	lower 22 km of the river flows through heavily used agricultural area and river is exposed to runoff and water extraction
Roads	X	adjacent roads and road runoff was observed frequently
Riparian Buffer	X	segment 1 has no riparian buffer as it flows through residential properties
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity	X	segment 2 is prone to beaver activity; dams may restrict upstream fish migration
Miscellaneous		
Hatchery supplemented	Yes	coho and chum stocked by the Tynehead Hatchery

Number of coho and chum juveniles stocked in Serpentine River by the Tynehead Hatchery from 1999 to 2005.

Species	Release Year	# Released
COHO	1999	82,000
	2000	95,000
	2001	109,000
	2002	22,000
	2003	16,000
	2004	90,000
	2005	60,700
CHUM	1999	210,000
	2000	210,000
	2001	210,000
	2002	180,000
	2003	190,000
	2004	190,000
	2005	150,000

Number of coho and chum counted through the Tynehead Hatchery fish fence from 2003 to 2005.

Species	Year	Wild Adults	Wild Jacks	Total Wild	Hatchery Adults	Hatchery Jacks	Total Hatchery	TOTAL
COHO	2003	n/a	n/a	n/a	n/a	n/a	n/a	**1,031**
	2004	758	n/a	758	625	n/a	625	**1,383**
	2005	233	n/a	233	30	n/a	30	**263**
CHUM	2003	192	n/a	192	n/a	n/a	n/a	**192**
	2004	582	n/a	582	n/a	n/a	n/a	**582**
	2005	393	n/a	393	n/a	n/a	n/a	**393**

NOTE: *2003 fence counts of coho were not segregated into wild vs. hatchery totals.*

SIDDLE (BELLS, TATHUM) CREEK

Watershed Code: 100-0728-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Siddle Creek is approximately 6 km long (~900 m surveyed) and flows south into Nicomen Slough, east of Deroche. The creek is steep in the upper 4 km, changing in the lower 1.3 km to a slower meandering channel with excellent gravel deposits (Schubert 1982). The lower portions of the creek primarily flow through agricultural lands.

METHODS

Study Area: The surveyed area extends from the marker on the barbed-wire fence, north of the Malcolm Road culvert crossing, northwest to the Lougheed Highway (#7) bridge crossing. This creek was surveyed for coho and chum from 2001 to 2004 (excluding 2003). In 2001, there were two survey segments totaling ~ 1000 m long. In 2002, this was further broken up into nine segments to identify for spatial spawning distribution in the survey area. In 2004, the survey area was again divided, for a total of three survey segments. Upper and lower segment boundaries were variable among survey years. The surveyed segments are as follows:

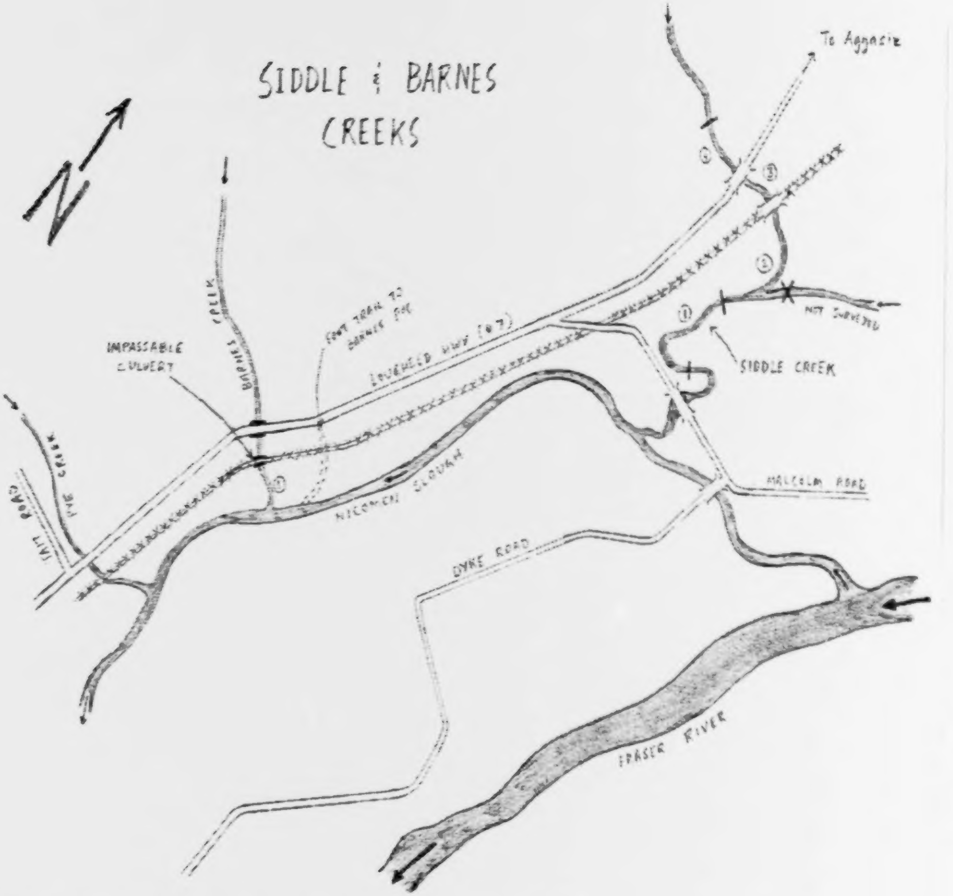
Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	fence marker	49°12'38" N 122°0'37" W	visible change in stream bed	49°12'45" N 122°0'39" W	300	10-15
2	marker	49°12'45" N 122°0'39" W	train tracks	49°12'55" N 122°0'35" W	400	15-25
3	train tracks	49°12'55" N 122°0'35" W	Highway #7	49°13'1" N 122°0'48" W	200	10-15

Segment 1 extends 300 m from the marker on the fence, just north of the Malcolm Road bridge crossing, north (upstream) to the marker at the visible change in streambed characteristic. Spawning habitat for coho and chum is extremely limited in the segment; substrate is mainly composed of large cobbles and boulders. The majority of this segment is exposed, with minimal cover from cutbanks and deep pools. The gradient is minimal and flows are slow, becoming slough-like in the lower sections of the segment. There is a small riparian buffer of small shrubs and tall grasses.

Segment 2 extends 400 m from the marker at the visible change in streambed characteristics, north (upstream) to the train track crossing. This segment exhibits excellent spawning habitat for coho and chum; bottom substrate is mostly composed of small loose gravel. There is moderate cover from instream woody debris and undercuts. The gradient increases gradually and the segment exhibits a constant riffle flow sequence. There is a moderate riparian buffer of mixed forest.

Segment 3 extends 200 m from the train track crossing, north (upstream) to the Lougheed Highway (#7) bridge crossing. There is minimal spawning habitat for coho and chum in the segment; bottom substrate is largely comprised of cobbles and boulders. There is very limited cover from cutbanks and instream woody debris. The gradient increases gradually and the segment exhibits a constant riffle flow sequence. There is a moderate riparian buffer of mixed forest.

***NOTE:** An additional 100m segment was added mid-season (2004) (upstream of the Highway #7 bridge crossing) to incorporate observed coho spawning distribution.*


SIDDLE & BARNES CREEKS
N
To Aggasiz
①
②
③
NOT SURVEYED
SIDDLE CREEK
LOUGHEED HWY (#7)
FOOT TRAIL TO BARNES CK
BARNES CREEK
IMPASSABLE CULVERT
PYE CREEK
TAIT ROAD
NICOMEN SLOUGH
MALCOLM ROAD
DYKE ROAD
FRASER RIVER

Siddle Creek (and Barnes Creek) sketch map (not to scale).

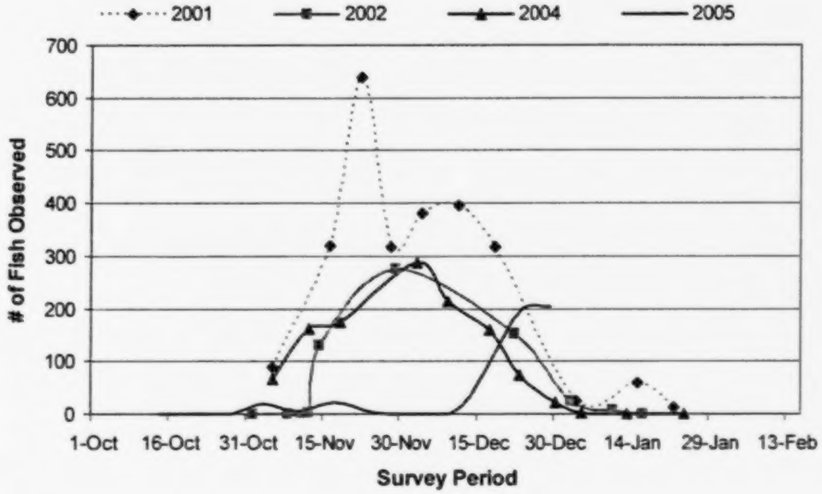
Survey Logistics: Two crew members are required to survey Siddle Creek. The survey area is accessed by driving east on Lougheed Highway (towards Hope) to Malcolm Road; turn right (southeast) on Malcolm and follow to Siddle Creek culvert crossing. To survey segments 1-3 survey from the marker north of the Malcolm Road bridge crossing, upstream to the Lougheed Highway (#7) bridge crossing. Follow Malcolm Road back to vehicle.

Proportion of Spawning Area: The creek is surveyed from very near it's confluence with Nicomen Slough, up to areas where spawning was historical assumed to end. The coverage of coho spawning area is assumed to be very good to excellent. There have been very few chum observed in Siddle Creek, but it is assumed that the coverage of possible spawning area is good to very good.

RESULTS

Observer Efficiency: Siddle Creek had a high average O.E. (0.74 ± 0.15) for all years assessed and was relatively consistent among segments. Visibility was reduced by instream cover (cutbanks, deep pools, and instream woody debris). Additionally, several beaver dams were generally built on this creek creating upstream pools that provide cover for coho and chum.

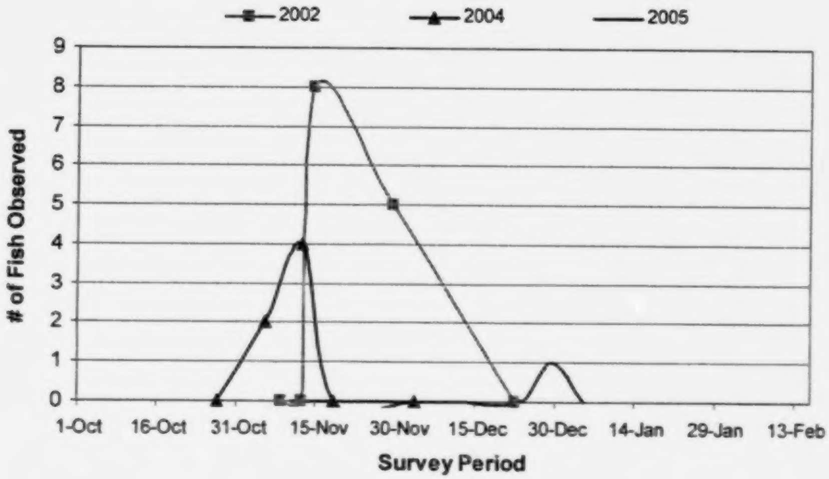
Coho Salmon: Run timing for coho was consistent among years beginning November 5-12, peaking November 22 to December 3, and ending January 10-22. Peak visual counts were moderately variable among survey years, ranging from 275-638 coho. Run timing was unimodal:



Coho escapement ranged from 315-1,706 in 2001 to 2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	2,085	1,023	1,076	384
10	n/a	n/a	1,877	920	968	346
11	**n/a**	**n/a**	**1,706**	**837**	**880**	**315**
12	n/a	n/a	1,564	767	807	288
13	n/a	n/a	1,444	708	745	266

Chum Salmon: For all years surveyed (2001, 2002, 2004, and 2005), escapement of chum into Siddle Creek was negligible. Due to the low run sizes, run timing trends and spawner densities could not be subjectively assessed, however, escapements were generated for each year. Run timing was unimodal:



Chum escapement was negligible ranging from 0-17 in 2001 to 2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	3	21	5	0
9	n/a	n/a	3	19	5	0
10	**n/a**	**n/a**	**3**	**17**	**4**	**0**
11	n/a	n/a	3	15	4	0
12	n/a	n/a	2	14	3	0

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.03 fish/m^2 (2005) to 0.042 fish/m^2 (2004), with an average of 0.038 fish/m^2 over 3 years. Average chum spawner density ranged from 0.002 fish/m^2 (2002) to 0.011 fish/m^2 (2004), with an average of 0.007 fish/m^2 over 2 years.

The greatest proportion (average: 0.63 fish/m^2) and greatest densities (average: 0.06 fish/m^2) of coho occurred in segment 2. Although coho were also observed in segment 1 and 3, most of these fish were holding/migrating fish. Only during peak coho spawning in 2004 was competition for available habitat observed in segment 2. Chum presence in the system was minimal for all survey years.

Spawning habitat was abundant in segment 2 (gravel substrate). Instream cover and riparian buffers (mixed-wood forest) were moderate in both segment 2 and 3. Spawning habitat was limited in segment 1 and the upper sections of segment 3; benthic substrate was predominantly large cobbles and boulders.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	segments 1 and 3 have extremely limited habitat (cobbles/boulders)
Instream Cover	X	segment 1 highly exposed
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer	X	segment 1 has a small riparian buffer
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

SILVERDALE (SILVER) CREEK

Watershed Code: 100-0519-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Silverdale Creek is approximately 8 km long (3.9 km surveyed) and flows south into the north side of the Fraser River (west end of Matsui Island) 5 km west of Mission. Its major tributaries include Proud and Gaudin Creek. The surveyed segments of Silverdale Creek flow through a wide range of habitat types including forested, industrial, residential, and agricultural areas. A temporary floating broodstock collection fence located 945 m upstream from Silverdale Creek's confluence with the Fraser River is operated by the Stave Valley Salmonid Enhancement Society.

METHODS

Study Area: The surveyed area extends from the marker located approximately 100 m upstream from the creek's confluence with the Fraser River, northeast to the marker located 470 m upstream from the falls (opposite Tyler Road) This creek was surveyed for coho and chum from 2001 to 2004 (excluding 2003). There were two survey segments in 2001, encompassing the area between the mouth and the temporary fish fence. In 2002, two segments were added encompassing another 1300 m upstream of the fish fence. In 2004, another 1550 m were added (one more survey segment) for a total of five survey segments. These segments were added to incorporate observed coho and chum spawning distribution. Upper and lower segment boundaries differed each survey year. The surveyed segments are as follows:

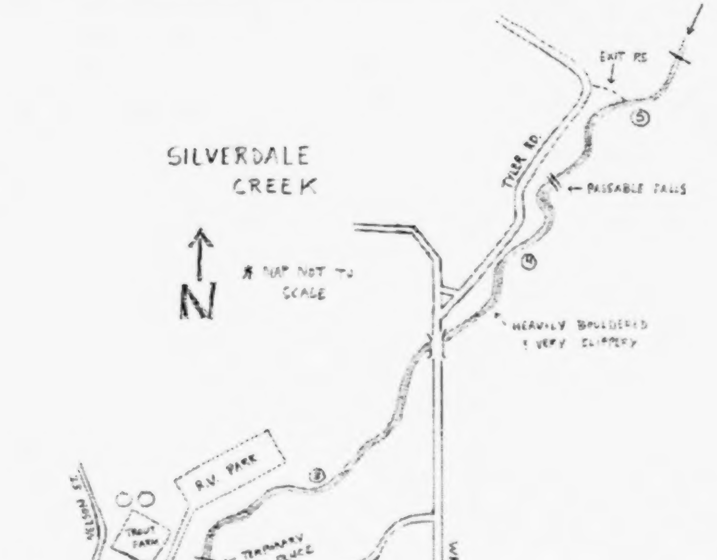
Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	marker ~100m u/s from mouth	49°8'3" N 122°21'28" W	Hwy 7 bridge	49°8'12" N 122°21'10" W	245	20-30
2	Hwy 7 bridge	49°8'12" N 122°21'10" W	fish fence	49°8'30" N 122°21'18" W	600	15-25
3	fish fence	49°8'30" N 122°21'18" W	Wren Rd. bridge	49°8'52" N 122°20'19" W	1700	40-60
4	Wren Rd. bridge	49°8'52" N 122°20'19" W	falls	49°9'18" N 122°20'2" W	1060	40-60
5	falls	49°9'18" N 122°20'2" W	marker 470m u/s of falls	49°9'34" N 122°19'50" W	470	10-15

Segment 1 extends 245 m from a marker located 100 m upstream of Silverdale Creek's confluence with the Fraser River, northeast (upstream) to the Lougheed Highway (Highway #7) bridge crossing. In this segment, spawning habitat is limited; the benthic substrate includes silts and clays in the lower sections and gravel and cobble in the upper sections. Instream cover is generally limited, except in the lower sections where deep dark pools provide cover for holding fish. The gradient is low and flow is moderate. Since this segment flows through a heavily used industrial area, the riparian buffer is limited.

Segment 2 extends 600 m from the Highway #7 bridge crossing, north to the temporary fish fence. Spawning habitat is abundant; benthic substrate includes loose gravel and cobble. Streamside vegetation provides instream cover for salmon. Riparian vegetation, however, is limited due to agricultural activities in this segment of the creek.

Segment 3 extends 1,700 m from the fish fence, upstream (northeast) to the Wren Road bridge crossing. Spawning habitat is abundant throughout this segment; benthic substrate includes loose small gravels and boulders. Instream cover is abundant and includes cutbanks, overhanging vegetation, and instream large woody debris. This segment is low gradient and flow is moderate but can be flashy in times of increased rainfall. In the lower sections of this segment the riparian buffer is limited due to residential land use (trout farm and trailer park) adjacent to the creek. In the upper sections of this segment the riparian buffer is abundant and is composed of deciduous and coniferous mixed forest.

Segment 4 extends 1,060 m from the Wren Road bridge crossing northeast to the first set of significant falls, which represents the observed upper boundary of chum spawning distribution. Spawning habitat is limited to small areas of gravel interspersed between the predominant benthic substrate of large boulders. Instream cover is abundant and includes deep pools, cutbanks, and large woody debris (instream log jams). This is a higher gradient segment characterized by faster flowing water and deep pools which can become unsafe to walk during periods of increased flow (increased rainfall). There is a limited riparian buffer on the north bank since it parallels and is immediately adjacent to Tyler Road. On the south bank, however, the riparian buffer is relatively large and flows through a mixed-wood forest.


SILVERDALE CREEK
N
* MAP NOT TO SCALE
EXIT PS
⑤
TYLER RD.
← PASSABLE FALLS
④
HEAVILY BOULDERED & VERY SLIPPERY
R.V. PARK
③
NELSON ST.
TROUT FARM
← TEMPORARY FISH FENCE
HEMLOCK ST.
SILVERDALE AVE
WREN ST.
②
TRIBUTARY (NOT SURVEYED)
ACCESS TRAIL
MILL
LOUGHEED HIGHWAY (#7)
→ TO MISSION
← RAILROAD BRIDGE
①
FRASER RIVER

Silverdale Creek sketch map (not to scale).

Segment 5 extends 470 m northeast of the falls; observed coho spawning distribution extends beyond this boundary. In this segment, benthic substrate is predominantly bedrock and small-sized gravel. Instream cover is abundant and includes deep pools, cutbanks, and overhanging vegetation. The gradient in this segment is low and flow is moderate. Adjacent riparian buffer is a wide and dense mixed-wood forest.

Survey Logistics: A minimum of two crew members are required to survey Silverdale Creek. To access the survey area, the crew drive east on the Lougheed Highway (towards Mission) to the mill across from Silverdale Road. To survey segments 1 and 2, one crew member is dropped off at the mill and enters the creek, via the mill parking lot access point, and surveys from the marker to the fish fence. The second crew member parks the vehicle at the fish fence and surveys from the fence to Wren Road bridge. The first crew member moves the vehicle to Wren Road bridge and surveys from there to the falls. The second crew member then moves the vehicle to the falls access point (flagged on Tyler Road) and surveys from there to the marker located 470 m upstream of the falls. When finished, this crew member walks down Tyler Road back to the vehicle.

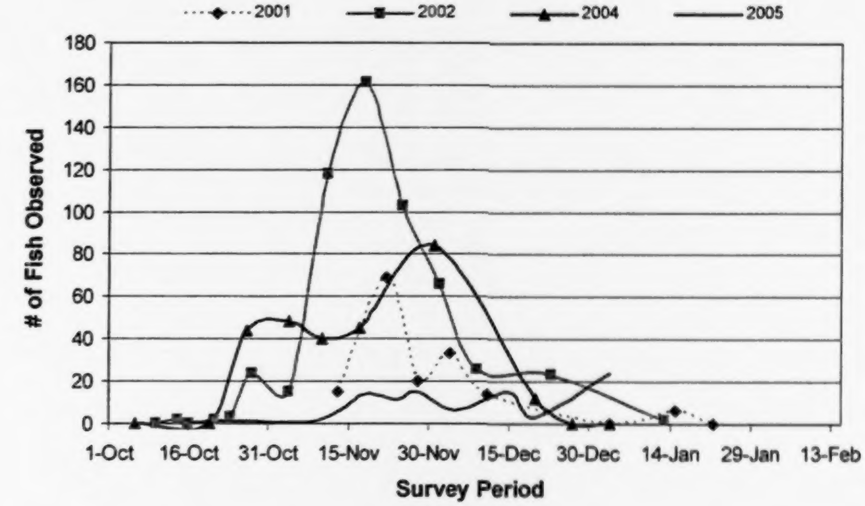
NOTE: *Segments three, four and five can pose a threat to the safety of a surveyor during rainfall events when water levels are increased.*

Proportion of Spawning Area: Historically, there are assumed to be coho spawning areas above the survey area. The coverage of coho spawning area is assumed to be good to very good. The coverage of chum spawning area is assumed to be very good to excellent.

RESULTS

Observer Efficiency: Silverdale Creek had moderate average O.E. (0.61 ± 0.13) for all segments and years assessed. For 2004, O.E. was moderate and there was little variation among survey segments (average for all segments: 0.75 ± 0.13). Visibility in segment 1 was limited by water clarity (dark water), surface glare (exposed to sunlight), and channel characteristics (wide channel widths and deep water). Segments 2, 3 and 5 are very similar in habitat types. Visibility is limited by the presence of instream cover habitat (cutbanks, instream woody debris, overhanging vegetation and deep pools). Lower O.E.s in segment 4 are attributed to the substrate type (large boulders create downstream riffle pools) and flow characteristics (rapid flow).

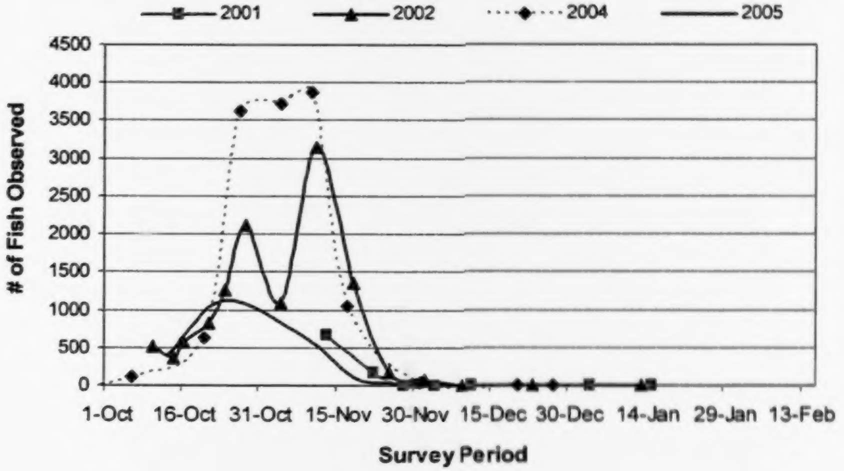
Coho Salmon: Run timing for coho was consistent among years, beginning October 14-27, peaking November 18 to December 1, and ending December 20 to January 13. Peak visual counts ranged from 84-161 coho. Run timing was bimodal:



Coho escapements ranged from 38-373 in 2002 to 2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	388	456	329	47
10	n/a	n/a	349	411	296	42
11	**n/a**	**n/a**	**317**	**373**	**269**	**38**
12	n/a	n/a	291	342	247	35
13	n/a	n/a	269	316	228	33

Chum Salmon: Run timing for chum was consistent among years beginning October 6-10, peaking October 24 to November 13 and ending December 1-9. Peak visual counts ranged from 627-3,869 chum. Run timing modality was variable:



Chum escapements ranged from 2,947-10,864 in 2002 to 2005 (R.T.: 10 days); R.T.s were based on the 2005 R.T. study result of 9 days (see Results section 3.5 Residence Time). Data for 2001 was excluded since the surveyed area did not cover the majority of chum spawning.

1999	2000	2001	2002	2004	2005
n/a	n/a	n/a	7,148	10,864	2,947

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.0005 fish/m^2 (2005) to 0.007 fish/m^2 (2001), with an average of 0.004 fish/m^2 over 4 years. Average chum spawner density ranged from 0.02 fish/m^2 (2005) to 0.127 fish/m^2 (2004), with an average of 0.089 fish/m^2 over 4 years.

The proportion of coho counted were similar between segments 2 (average: 0.32), 3 (average: 0.43) and 4 (average: 0.22) and lowest in segment 1 (average: 0.05). Coho densities were also similar between segments 2-4 (average: 0.006 fish/m^2) and lowest in segment 1 (average: 0.001 fish/m^2).

The greatest proportions and spawning densities of chum were observed in segment 3 (average proportion: 0.49 and average density: 0.175 fish/m^2), followed by segment 2 (average proportion: 0.26 and average density: 0.143 fish/m^2). No chum were observed in segment 5. Available spawning habitat did not appear to be limiting for either species.

Spawning habitat was most abundant in segments 2, 3 and 5 where benthic substrate was predominantly small gravel and cobble. Instream cover for these segments was also abundant and riparian buffers were moderate. Spawning habitat in segment 1 was limited to the upper sections of the segment. Benthic substrate in segment 1 was predominantly fines (sand, silt and clay) and this segment was highly exposed. Segment 4 also has limited spawning habitat as this segment is characterized by a steep gradient and cobble/boulder substrate.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	segment 1 has limited substrate (clays and silts in lower sections); segment 4 has limited substrate (boulders)
Instream Cover	X	section 1 has limited instream cover
Adjacent Land Use		
Residential	X	segment 3 runs through an RV park where residents and pets have unrestricted access
Agricultural	X	segment 2
Roads		segment 4
Riparian Buffer	X	segments 1-4 have limited buffer, flows through residential/industrial areas
Stream bank erosion		
Garbage	X	garbage bags containing potted plant soil and plant material were observed in the creek on several occasions
Spawning disturbance		
Beaver activity		
Miscellaneous		
Hatchery supplemented	Yes	coho and chum stocked by the Stave Valley Salmonid Society

Number and average weight of coho and chum juveniles stocked in Silverdale Creek from 1999 to 2005.

Species	Release Year	# Released	Avg. Weight (g)	Stage Released
COHO	1999	15,000	18	Smolts
	2000	14,000	25	Smolts
		30,000	2	Fed Spring
	2001	1,800	2	Fed Spring
	2002	35,000	20	Smolts
		25,000	2	Fed Spring
	2003	22,000	2	Fed Spring
	2004	65,000	20	Smolts
		15,000	2	Fed Spring
	2005	15,000	25	Smolts
		10,000	2	Fed Spring
CHUM	1999	28,000	1	Fed FW
	2000	44,000	1	Fed FW
	2001	40,000	1	Fed FW
	2002	50,000	1	Fed FW
	2003	40,000	1	Fed FW
	2004	50,000	1	Fed FW
	2005	not enhanced		

SQUAWKUM CREEK

Watershed Code: 110-0369-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Squawkum Creek is approximately 920 m long and flows east out of Lake Errock (Mission) into Harrison Bay. The entire length of the creek is surveyed. The upper portions of the creek primarily flow through residential and undisturbed forested areas while the lower portions flow through fairly dense marshland.

METHODS

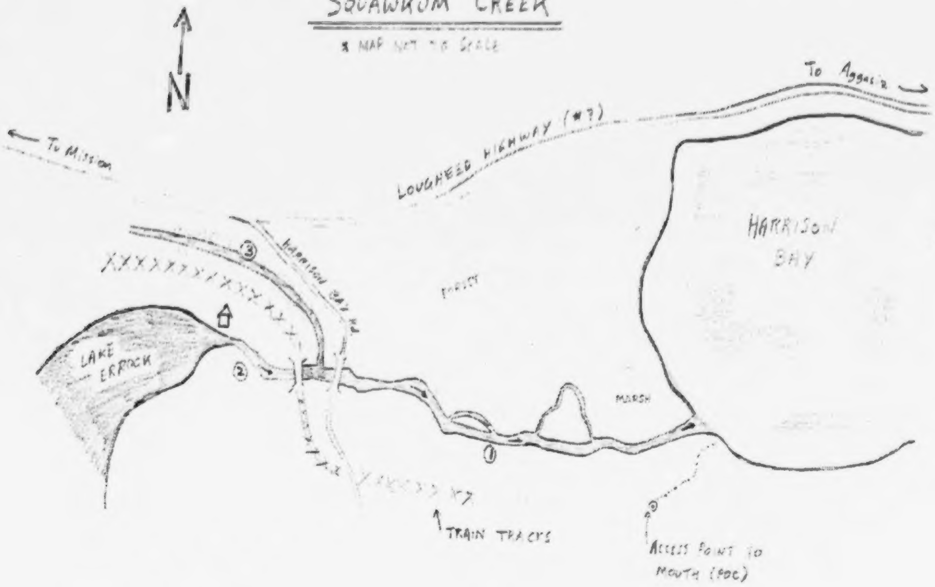
Study Area: The survey area extends from Harrison Bay, west to Lake Errock and also includes 350 m of a tributary that parallels the CN railroad tracks. This creek was surveyed for coho and chum in 2002 and 2004. In 2002, there were two survey segments, covering from the mouth (Harrison Bay) to Lake Errock. An additional segment was added mid-season (2002); a tributary (350 m long) that enters the creek just downstream of the Harrison Bay Road bridge crossing. Segment distances and boundaries were identical in 2004. The survey segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	mouth (into Harrison Bay)	49°13'58" N 121°59'47" W	railroad bridge crossing	49°13'58" N 122°0'16" W	760	30-60
2	railroad bridge crossing	49°13'58" N 122°0'16" W	outlet (from Lake Errock	49°13'57" N 122°0'18" W	160	5-10
3	railroad bridge crossing	49°13'57" N 122°0'18" W	marker @ 350m point	49°13'55" N 122°0'27" W	350	10-15

Segment 1 extends 760 m from its outlet into Harrison Bay west (upstream) to the railroad bridge. Throughout this segment spawning habitat for chum and coho is abundant; the benthic substrate is predominantly loose smaller gravel and cobbles. The first 350 m of the segment flows through marshland, providing excellent instream cover that includes undercuts and overhanging marsh vegetation. In this lower section there are a number of active beaver dams that restrict water flow consequently raising water levels limiting visibility of salmon during surveys. The upper 400 m of the segment primarily flows through an undisturbed forested area. Instream cover is excellent and includes overhanging vegetation and instream large woody debris. The canopy is dense with a fairly large riparian buffer present on both sides.

Segment 2 extends 160 m from the railroad bridge west (upstream) to the outlet of Lake Errock. In this segment spawning habitat for coho and chum is extremely limited; the benthic substrate includes large boulders and sands. Instream cover is limited to deep pools and overhanging streamside vegetation. The gradient of this segment is very low and flows are slow. Riparian vegetation is limited as this segment flows through industrial and residential areas.

Segment 3 (a tributary to Squawkum Creek) extends 350 m from the railroad bridge, southwest (upstream) to the marker. Spawning habitat is abundant; benthic substrate is small-sized gravel. Instream cover is abundant and includes overhanging vegetation, cutbanks, and instream woody debris. This segment is quite narrow (~5-10 feet) and has very low gradient and associated slow flow pattern. There is little riparian buffer due to the railroad on the south side and residential development on the north.



Squawkum Creek sketch map (not to scale).

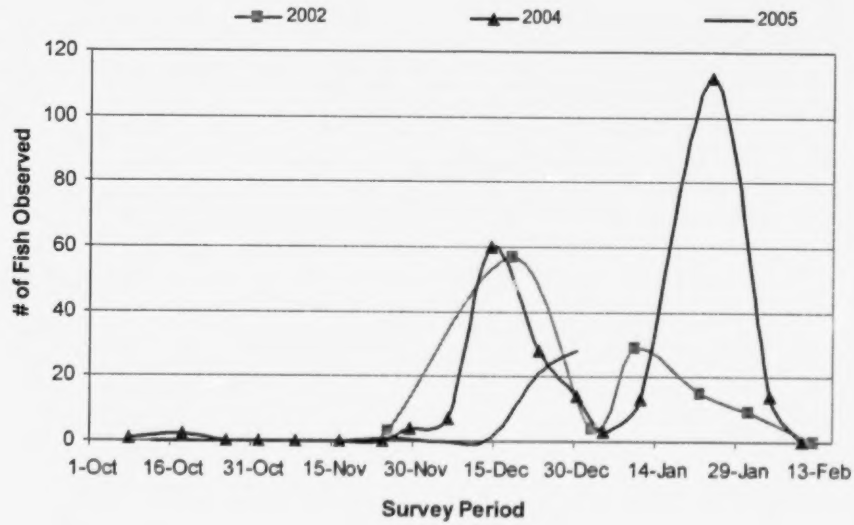
Survey Logistics: Two crew members are required to survey Squawkum Creek. To access the survey area, the crew drive east on the Lougheed Highway (#7), turn right on Harrison Bay Road, and drive past the Squawkum Creek bridge crossing. The vehicle is parked at the small pullout just south of that bridge. To survey segment 1, two crew members walk ~ 450 m east down the railroad tracks to the marker. They enter north into the marsh and follow the trail leading to the mouth (Harrison Bay). At the mouth, the crew walk upstream from Squawkum Creek's outlet (to Harrison Bay) to the railroad bridge. In this segment, spawning numbers particularly for chum are extremely high (up to 6000 fish). The best precision for the visual assessment of spawners in the segment is obtained through an independent count by each surveyor. During narrow sections of the creek, both surveyors count the coho and chum observed separately. During wider sections, walking shoulder to shoulder, each surveyor counts their side of the creek only. After a wide section, crew members exchange their respective counts so that each surveyor will have a complete count at the end of the segment. A count of individual fish versus counting in numbers of ten appears to produce the greatest precision in this segment. To survey segments 2 and 3, the two surveyors split up at the railroad bridge and proceed separately upstream to their segments respective endpoints described above. The surveyors then back track to return to the vehicle.

Proportion of Spawning Area: Coverage of spawning areas, for both coho and chum, are assumed to be very good to excellent.

RESULTS

Observer Efficiency: Observer efficiency was relatively high and consistent among survey segments: segment 1 average: 0.77 ± 0.10; segment 2 average: 0.72 ± 0.22; segment 3 average: 0.78 ± 0.09. Visibility in segment 1 was excellent; the major limiting factors for O.E. were fish densities and inter-species mixing. Segment 2 had the lowest O.E. of all segments due to the presence of deep pools where fish stacking was an issue. In segment 3, high observer efficiencies were attributed to excellent water clarity (clear water), substrate colour (high contrast among substrate and spawners), slow flows, and ideal channel characteristics (shallow water and narrow channel widths).

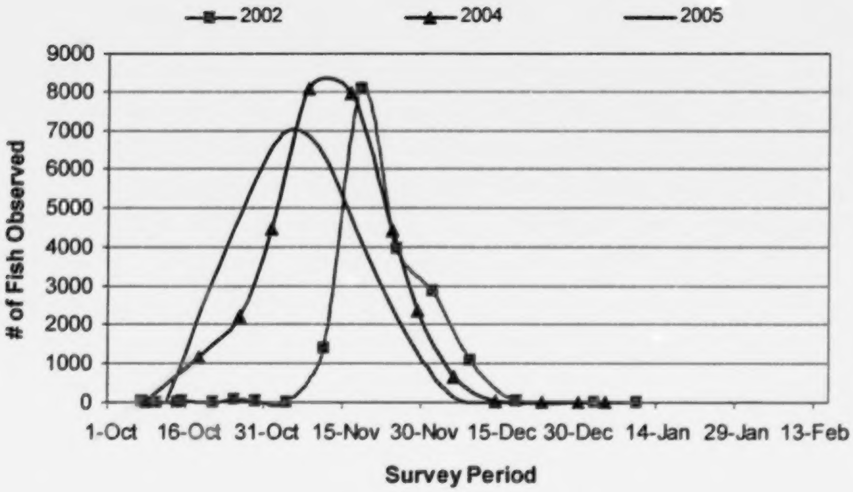
Coho Salmon: Run timing for coho was consistent among years beginning November 25-29 and ended from January 31 to February 4. Run timing was bimodal: the initial peak ranged from December 14-18 and the second peak ranged from January 10-24:



Coho escapements ranged from 61-230 in 2002 to 2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	n/a	144	281	75
10	n/a	n/a	n/a	129	253	67
11	**n/a**	**n/a**	**n/a**	**118**	**230**	**61**
12	n/a	n/a	n/a	108	211	56
13	n/a	n/a	n/a	99	194	52

Chum Salmon: Run timing for chum was also consistent among years beginning October 8-10, peaking November 8-18, and ending December 1-9. Peak visual counts ranged from 6,911 to 8,083 chum. Run timing was unimodal:



Chum escapements ranged from 12,459-22,762 in 2002 to 2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	n/a	15,573	28,452	22,105
9	n/a	n/a	n/a	13,843	25,291	19,649
10	**n/a**	**n/a**	**n/a**	**12,459**	**22,762**	**17,684**
11	n/a	n/a	n/a	11,326	20,692	16,076
12	n/a	n/a	n/a	10,382	18,968	14,737

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.002 fish/m^2 (2005) to 0.024 fish/m^2 (2004), with an average of 0.01 fish/m^2 over 3 years. Average chum spawner density ranged from 0.477 fish/m^2 (2002) to 0.611fish/m^2 (2005), with an average of 0.56 fish/m^2 over 3 years.

The greatest proportion of coho was observed in segments 2 (average: 0.42) and 3 (average: 0.35), while the greatest proportion of chum was observed in segment 1 (average: 0.74). Coho densities were lowest where chum densities were high. During peak chum spawning, overlapping redds were frequently observed in segment 1 where densities were very high (average: 0.57 fish/m^2).

Spawning habitat in segments 1 and 3 was abundant; benthic substrate was predominantly small gravel and there was excellent instream cover. There was extremely limited spawning habitat in segment 2 since this segment was relatively deep and benthic substrate was predominantly large cobbles and boulders. The riparian buffer was most significant in segment 1; segments 2 and 3 were adjacent to residential development.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	segment 2 has limited spawning habitat (boulders/sand)
Instream Cover		
Adjacent Land Use		
Residential	X	segment 2 flows through residential and industrial property; segment 3 flows through residential property
Agricultural		
Roads		
Riparian Buffer	X	limited in segment 2 that flows through residential and industrial property; segment 3 is limited since it flows adjacent to a railroad and residential development
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity	X	lower sections of segment 1 have active beaver dams that restrict water flow
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

STREET CREEK

Watershed Code: 100-0657-097-074-000-000-000-000-000-000-000

CREEK DESCRIPTION

Street Creek is approximately 3.6 km long (~1.3 km surveyed) and flows west into the south side of the Chilliwack River (~3 km east of Yarrow). The creek is spring fed and has two tributaries, the major one being Hopedale Slough. The surveyed portions of the creek flow through agricultural and residential areas.

METHODS

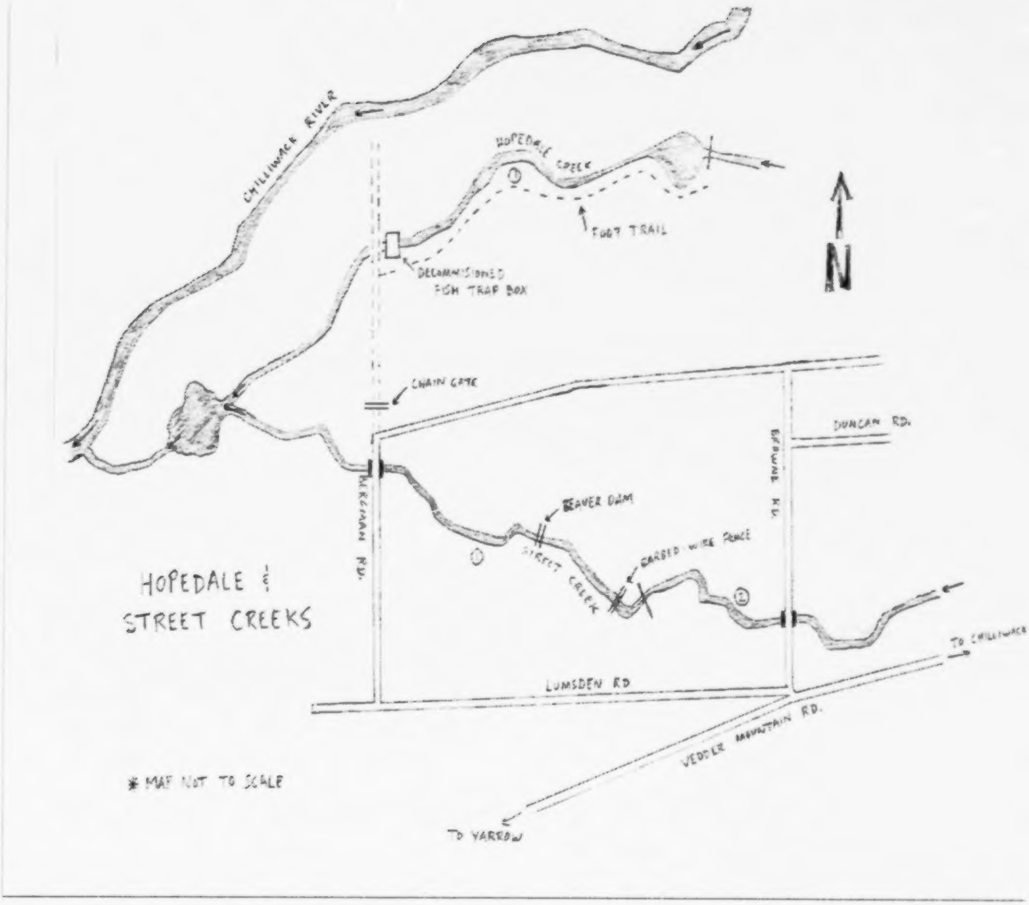
Study Area: The survey area extends from the culvert crossing on Bergman Road, east to the bridge crossing on Browne Road. This creek was surveyed for coho from 1999 to 2004 (excluding 2003) and for chum from 2001 to 2004 (excluding 2003). From 1999 to 2001, there was one survey segment. In 2002, this segment was divided in half (two segments) to identify spawning distribution; this was mirrored in 2004. Over all five survey years, upper and lower survey boundaries have been identical, but are outlined in this report as one segment for comparative purposes. The survey segments are as follows:

Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Bergman Rd. culvert	49°5'34" N 122°1'44" W	Browne Rd. culvert	49°5'26" N 122°1'5" W	1275	25-40

Segment 1 extends 1,275 m from the culvert crossing on Bergman Road east (upstream) to the culvert crossing on Browne Road. In this segment, spawning habitat is limited; the benthic substrate includes gravel, cobbles, and small randomly dispersed sandy areas. Instream cover is moderate and includes aquatic vegetation, streamside vegetation, and cutbanks. No large woody debris accumulation occurs in the creek, although beaver activity (dams) can restrict upstream fish migration. The flow of the surveyed area remains relatively slow (due to groundwater influence) even during periods of heavy rainfall. Since the survey area flows through residential and agricultural areas, there is no riparian buffer.

Survey Logistics: A two person crew is required to survey Street Creek. To access the survey area, the crew drives west on Vedder Mountain Road (Chilliwack) and turn right onto Lumsden Road. They follow Lumsden Road west and turn right on Bergman Road and follow Bergman Road to the Street Creek culvert crossing and drop off one crew member. To survey segment 1, the dropped off crew member enters at the culvert and walks upstream (east) to the Browne Road. culvert where the other crew member has parked the vehicle and is waiting. Street Creek surveys were conducted on the same day as Hopedale Slough surveys due to their close proximity to each other.

***NOTE:** Difficulties encountered while surveying segments that are in close proximity to private residences include dogs, and barriers crossing the creek including barbed wire and wooden fences.*


CHILLIWACK RIVER
HOPEDALE CREEK
①
FOOT TRAIL
DECOMMISSIONED FISH TRAP BOX
N
CHAIN GATE
DUNCAN RD.
BROWNE RD.
ERGMAN RD.
BEAVER DAM
①
STREET CREEK
BARBED WIRE FENCE
②
HOPEDALE & STREET CREEKS
LUMSDEN RD
TO CHILLIWACK
VEDDER MOUNTAIN RD.
* MAP NOT TO SCALE
TO YARROW

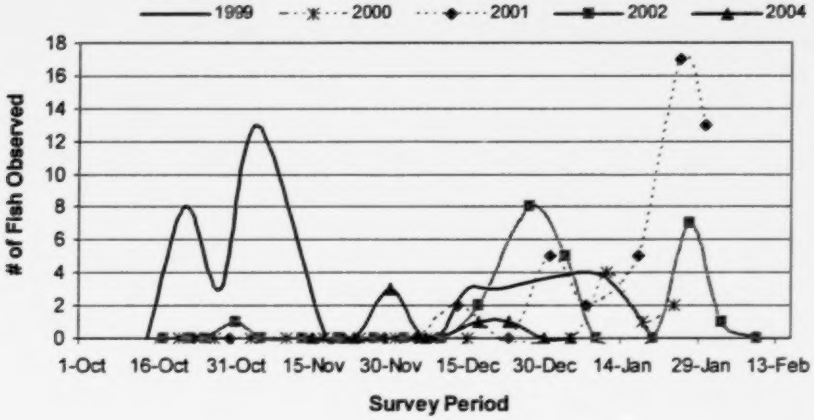
Street Creek (and Hopedale Slough) sketch map (not to scale).

Proportion of Spawning Area: There are some unsurveyed areas above and below the survey area. There have been very few coho observed on this survey, but the coverage of possible spawning areas is assumed to be good to very good. The coverage of chum spawning areas are assumed to be very good.

RESULTS

Observer Efficiency: Street Creek had a high average O.E. (0.72 ± 0.12) for all years assessed. Excellent visibility was attributed to good water clarity (clear), limited instream cover habitat, relatively narrow channel widths, and low flows. Visibility was adversely affected by surface glare, instream vegetation, and the many barriers (barbed wire, wooden and electric fences) to the surveyors' upstream movement.

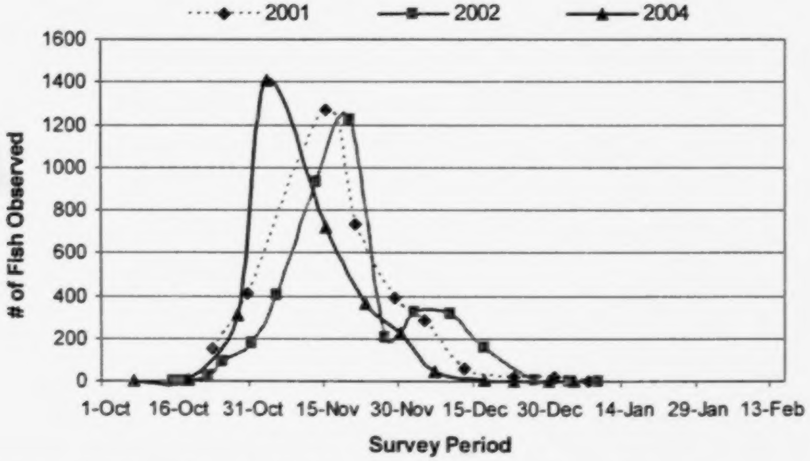
Coho Salmon: Run timing for coho was considerably variable among years, beginning October 21 to December 17, peaking November 4 to January 25, and ending December 23 to January 30. Irregular run timing is most likely attributed to the small numbers of coho that use this creek.



Coho escapements ranged from 2-31 coho in 1999 to 2004 (R.T.: 11 days)

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	36	3	38	13	15	n/a
10	33	3	34	12	14	n/a
11	**30**	**2**	**31**	**11**	**12**	**n/a**
12	27	2	29	10	11	n/a
13	25	2	26	9	11	n/a

Chum Salmon: Run timing for chum was consistent among years, beginning October 22-28, peaking November 3-20, and ending December 23-31. Peak visual counts ranged from 1,224 to 1,410 chum. Run timing is unimodal:



Chum escapement ranged from 2,682-2,990 in 2001 to 2004 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	3,738	3,352	3,400	n/a
9	n/a	n/a	3,323	2,980	3,023	n/a
10	**n/a**	**n/a**	**2,990**	**2,682**	**2,720**	**n/a**
11	n/a	n/a	2,718	2,438	2,473	n/a
12	n/a	n/a	2,492	2,235	2,267	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.0004 fish/m^2 (2000) to 0.003 fish/m^2 (2002), with an average of 0.001 fish/m^2 over 5 years. Average chum spawner density ranged from 0.071 fish/m^2 (2004) to 0.079 fish/m^2 (2002), with an average of 0.074 fish/m^2 over 3 years.

Coho densities were relatively low in all segments, with the greatest proportion of coho counted in segment 2 (average: 0.86). Chum were observed at much higher densities than coho with the greatest proportion (average: 0.70) and densities (0.088 fish/m^2) observed in segment 2.

Spawning habitat was intermittent throughout the survey area and was limited to interspersed gravel pockets in riffles.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	limited
Instream Cover		
Adjacent Land Use		
Residential	X	flows through residential properties
Agricultural	X	flows through agricultural areas; fences that span the creek have been observed to cause debris jams that restrict fish migration
Roads		
Riparian Buffer	X	none
Stream bank erosion		
Garbage		
Spawning disturbance		farm dogs and livestock have unrestricted access to the creek and have been observed walking in creek; dogs have been observed harassing salmon
Beaver activity	X	dams can restrict upstream salmon migration
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum; although not observed, some straying of stocked coho or chum in the Chilliwack may occur

WEST CREEK

Watershed Code: 100-0416-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

West Creek is approximately 6 km long (~5 km surveyed) and flows north into the south side of the Fraser River, east of McMillan Island. The creek originates in a low-lying marshy area, flows through a densely wooded gulley 5 km downstream and subsequently flows onto the Fraser River floodplain where it meanders through exposed farmland, becoming slough-like in the lower 200 m (Schubert 1982).

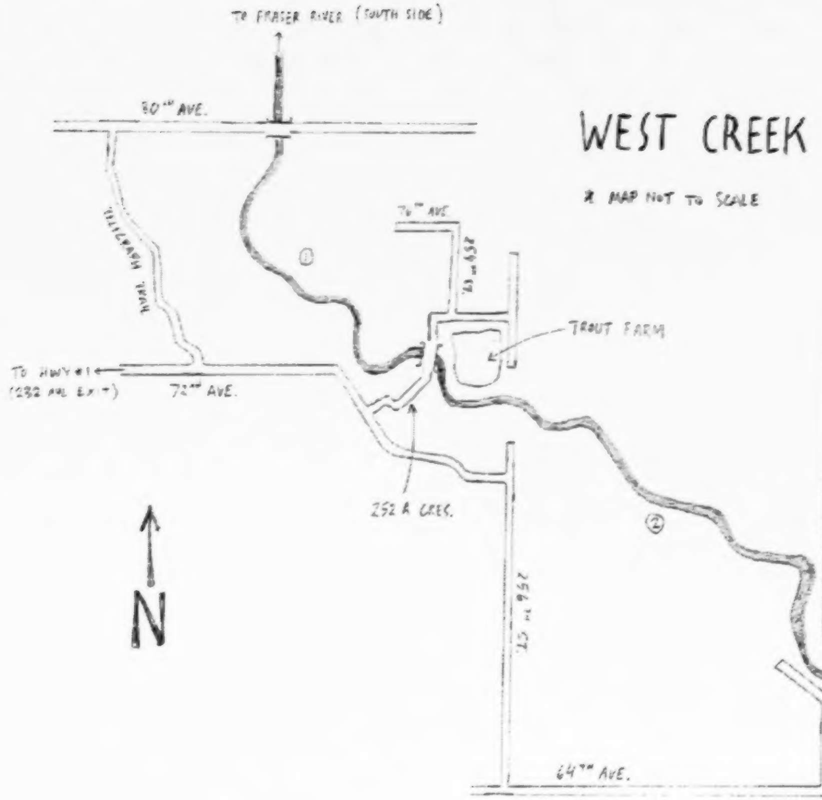
METHODS

Study Area: The surveyed area extends from the bridge 80th Avenue bridge crossing, southeast to the 264th Street bridge crossing. This creek was surveyed for coho and chum in 2000 and 2001. Segment distances and upper and lower survey boundaries were identical over these two survey years. The surveyed segments are as follows:

Segm-ent	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	80 Ave bridge crossing	49°8'51" N 122°31'54" W	252 A Cres. Bridge crossing	49°8'2" N 122°31'19" W	2400	60-90
2	252 A Cres. Bridge crossing	49°8'2" N 122°31'19" W	264 St bridge crossing	49o7'22" N 122o29'30" W	2600	60-90

Segment 1 extends 2,400 m from the 80th Avenue bridge crossing, south (upstream) to the 252nd A Crescent bridge crossing. Spawning habitat is abundant and distributed evenly throughout the segment with the largest concentrations of suitable habitat occurring the upper sections. Substrate is mainly comprised of small loose gravel, interspersed with cobbles, boulders, and fines. In the lower sections of this segment fines (silts and sands) are the predominant substrate type. In-stream cover is excellent throughout the segment and includes instream woody debris, cutbanks, deep pools, and overhanging streamside vegetation. The gradient gradually increases and flows are moderate. The majority of the segment has an excellent riparian buffer of mixed wood forest flowing through rurally developed residential areas in the lower sections.

Segment 2 extends 2,600 m from the 252nd A Crescent bridge crossing, southeast (upstream) to the 264th Street bridge crossing. There is excellent spawning habitat throughout this segment, with the highest quality spawning grounds located in the lower sections of the segment; bottom substrate is largely comprised of loose gravels in the lower sections shifting to predominantly fines in the upper sections of the segment. In-stream cover is excellent throughout the segment and includes instream woody debris, cutbanks, deep pools, and overhanging streamside vegetation. The gradient is low and flows can be quite slow, often completely drying up in the upper sections of the segment. The majority of the segment has an excellent riparian buffer of mixed wood forest, however, the upper sections are exposed to heavily used agricultural lands with no riparian buffer.


TO FRASER RIVER (SOUTH SIDE)
80TH AVE.
WEST CREEK
* MAP NOT TO SCALE
TELEGRAPH TRAIL
76TH AVE
254TH ST.
①
TROUT FARM
TO HWY #1 (232 AVE EXIT)
72ND AVE.
252 A CRES.
264TH ST.
②
N
256TH ST.
64TH AVE.

West Creek sketch map (not to scale).

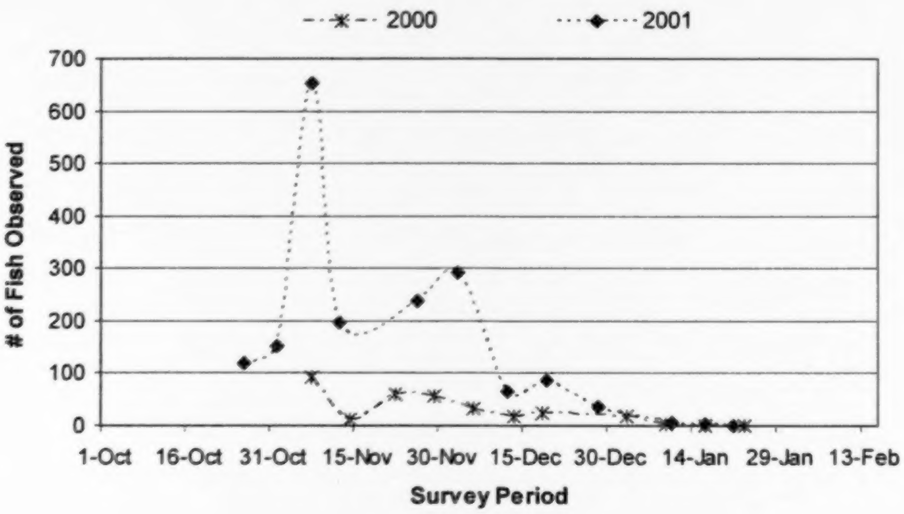
Survey Logistics: Four crew members are required to survey West Creek. To access the survey area, the crew drive east on Highway #1 (towards Abbotsford) to the 232nd Avenue north exit and turn right (east) onto 72nd Avenue and then turn left (north) on Telegraph Trail Road. They follow Telegraph Trail Road and turn right (east) on 80th Avenue and follow this road to West Creek bridge crossing where they park the vehicle. To survey segment 1, two crew members survey from the 80th Avenue bridge crossing, to the 252A Crescent bridge crossing. To access segment 2, the crew drive back to Telegraph Trail Road (south) and turn left (east) on 72nd Avenue and turn left (south) onto 252A Crescent, and follow to the bridge crossing. To survey segment 2, two crew members survey from the 252A bridge crossing south to the 264th Street bridge crossing.

Proportion of Spawning Area: Coverage of coho spawning area is assumed to be very good to excellent. There is unsurveyed area below the survey area that most likely contains chum spawning area. The coverage of chum spawning area is assumed to be moderate to good.

RESULTS

Observer Efficiency: West Creek had a moderate average O.E. (0.64 ± 0.19) for all segments and years assessed. Observer efficiency was relatively consistent among segments: segment 1 average: 0.66 ± 0.09; segment 2 average: 0.65 ± 0.08 (Figure 100). Visibility in the surveyed area was reduced by water clarity (slightly discolored water) and instream cover (cutbanks, instream woody debris, deep pools). Surface glare is limited by the wide and consistent riparian buffer.

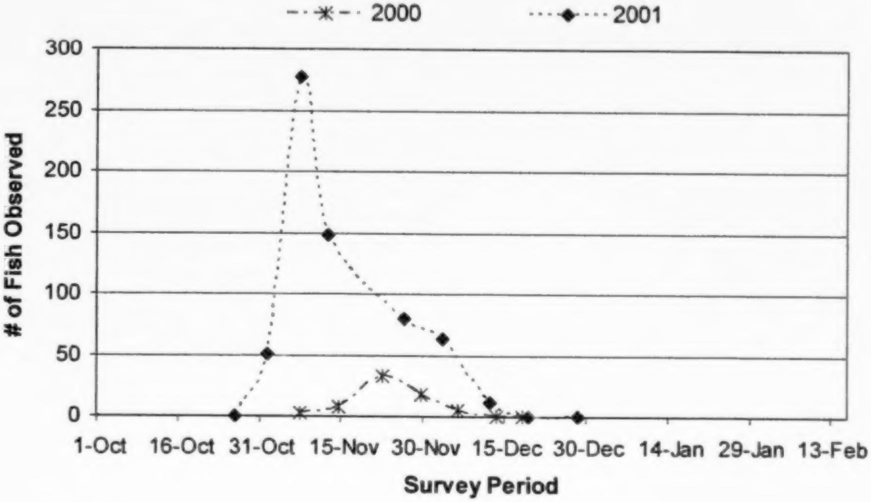
Coho Salmon: Run timing for coho was consistent among years beginning October 27 to November 7 and ending January 9-16. Peak visual counts ranged from 93-651 and run timing was bimodal:



Coho escapements ranged from 223-1,201 in 2000 and 2001 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	272	1,468	n/a	n/a	n/a
10	n/a	245	1,321	n/a	n/a	n/a
11	**n/a**	**223**	**1,201**	**n/a**	**n/a**	**n/a**
12	n/a	204	1,101	n/a	n/a	n/a
13	n/a	189	1,016	n/a	n/a	n/a

Chum Salmon: Run timing for chum was consistent among all years, beginning October 8-10, peaking November 7-22, and ending December 18-23. Peak visual counts ranged from 33-277 chum and run timing was unimodal:



Chum escapements ranged from 48-467 in 2000 and 2001 (R.T.: 10 days)

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	584	n/a	n/a	n/a
9	n/a	n/a	519	n/a	n/a	n/a
10	**n/a**	**n/a**	**467**	**n/a**	**n/a**	**n/a**
11	n/a	n/a	425	n/a	n/a	n/a
12	n/a	n/a	389	n/a	n/a	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.003 fish/m^2 (2000) to 0.01 fish/m^2 (2001), with an average of 0.007 fish/m^2 over 2 years.

In 2000, when coho escapement was low, the greatest proportion of coho observed spawning were in segment 1 (0.80). In 2001, when coho escapement was higher, the greatest proportion of coho occurred in segment 2 (0.76)

Although spawning habitat was abundant throughout the entire survey area, chum spawned almost exclusively in segment 1 (average proportion: 0.985 and average density: 0.008 fish/m^2). Spawning habitat was not limiting for either species.

Spawning habitat was abundant in both segments; benthic substrate was predominantly loose gravel and instream cover included woody debris, cutbanks, and deep pools. Most coho were observed in the upper sections of segment 1 and throughout segment 2.

	Concern	Comments
Flow/Gradient	X	upper sections of segment 2 was observed dry on many occasions during the fall and winter months; runoff during rainfall increases turbidity of creek
Spawning Substrate	X	lower sections of segment 1 have limited habitat (fines)
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural	X	upper sections of segment 2 flow through agricultural lands
Roads		
Riparian Buffer	X	upper sections of segment 2 limited buffer
Stream bank erosion		
Garbage		
Spawning disturbance	X	upper sections of segment 2 have livestock with unrestricted creek access
Beaver activity		
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

WHONNOCK CREEK

Watershed Code: 100-0453-000-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Whonnock Creek is approximately 12 km long (~3 km surveyed) and flows south into the north side of the Fraser River at the west end of Crescent Island. The creek originates from mountain drainage and enters a narrow valley, with steep impassable gradient. Between 4.8 and 8 km there are excellent gravel deposits and the channel meanders across a broad plateau and marsh located at the mouth of Whonnock Lake (Schubert 1982).

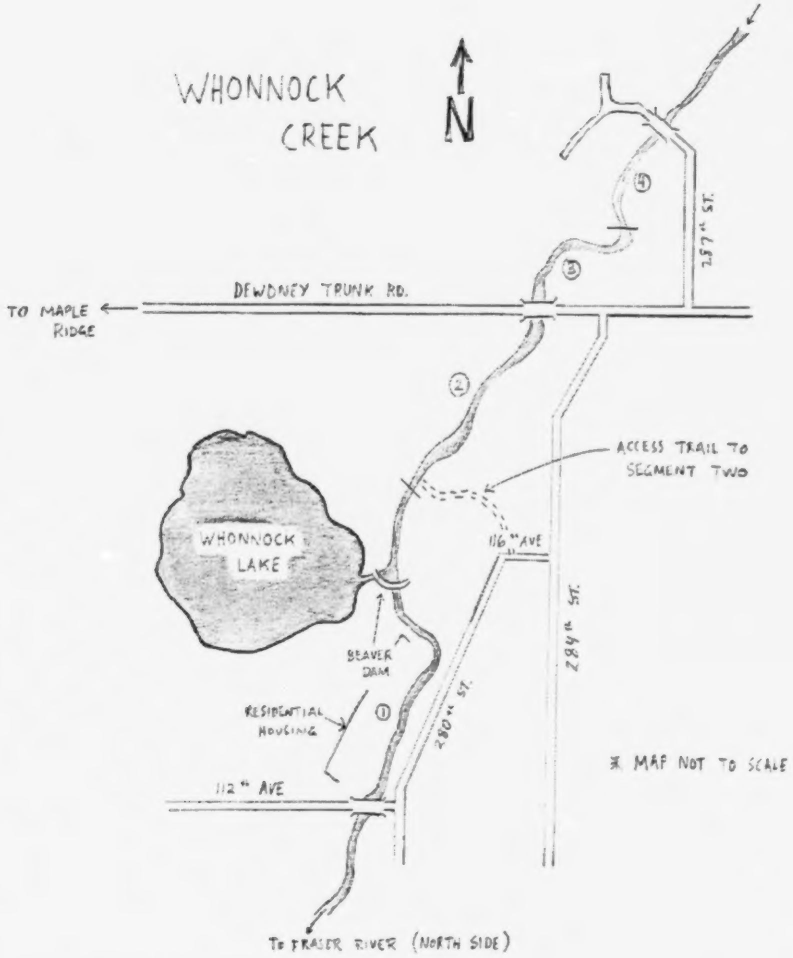
METHODS

Study Area: The surveyed area extends from the 112th Avenue bridge crossing, north to the 287th Street bridge crossing, in Mission. This creek was surveyed for coho from 1999 to 2004 (excluding 2003) and for chum from 2001 to 2004 (excluding 2003). From 1999 to 2001, there were three survey segments. In 2002, the survey area was further divided into five segments and in 2004 there were four segments. For all five survey years, upper and lower survey boundaries were identical. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	112 Ave bridge crossing	49°12'20" N 122°26'35" W	Beaver dam just below whonnock lake	49°12'41" N 122°26'28" W	670	20-30
2	Acces point u/s of beaver dam	49°12'51" N 122°26'21" W	Dewdney trunk bridge crossing	49°13'12" N 122°26'2" W	1275	35-50
3	Dewdney trunk bridge crossing	49°13'12" N 122°26'2" W	marker @ visible change in stream bed	49°13'28" N 122°25'45" W	750	15-30
4	marker @ visible change in stream bed	49°13'28" N 122°25'45" W	287 Ave bridge crossing	49°13'35" N 122°25'37" W	300	10-15

Segment 1 extends 670 m from the 112th Avenue bridge crossing, north (upstream) to the beaver dam just below Whonnock Lake. Spawning habitat is limited in this segment as benthic substrate is predominantly large cobbles and boulders with only a few small areas of gravel. Instream cover (boulder pools and streamside vegetation) is also limited. The gradient slowly but constantly increases, with the greatest flows occurring at the upstream boundary of the segment. The lower sections of the segment flow through residential development with no riparian buffer and the upper sections have a riparian buffer of mixed deciduous trees and shrubs.

Segment 2 extends 1,300 m from the access point (via 116th Avenue) marker, north (upstream) to the Dewdney Trunk bridge crossing. Spawning habitat in this segment is limited; benthic substrate includes large boulders interspersed with areas of small-sized gravel. Instream cover is excellent and includes cutbanks, overhanging streamside vegetation, and deep pools. The gradient is gradual and flows are moderate with small sections of faster flows. The segment flows through a developed residential area and, consequently, the riparian buffer is less dense where development is greatest.


WHONNOCK CREEK
N
④
287th ST.
③
DEWDNEY TRUNK RD.
TO MAPLE RIDGE
②
ACCESS TRAIL TO SEGMENT TWO
WHONNOCK LAKE
116th AVE
284th ST.
BEAVER DAM
RESIDENTIAL HOUSING
①
280th ST.
* MAP NOT TO SCALE
112th AVE
TO FRASER RIVER (NORTH SIDE)

Whonnock Creek sketch map (not to scale).

Segment 3 extends 750 m from the Dewdney Trunk Road bridge crossing, northeast (upstream) to the marker at the visible change of instream bed characteristics. Spawning habitat is limited; benthic substrate includes large cobble/boulder clusters interspersed with small areas of spawning gravel. Instream cover is excellent and includes streamside vegetation, deep pools, cutbanks, and instream woody debris. The gradient is low and flows are moderate. There is an excellent riparian buffer of mixed wood forest on both banks.

Segment 4 extends 300 m from the marker at the visible change instream bed characteristics, northeast (upstream) to the 287th Street bridge crossing. Over the entire survey area (segments 1 - 4), segment 4 has the greatest availability of suitable spawning habitat; benthic substrate is almost entirely small-sized loose gravel. Instream cover is excellent and includes cutbanks and overhanging streamside vegetation. The gradient is low and flows are slow. There is an excellent riparian buffer of mixed-wood forest on both banks.

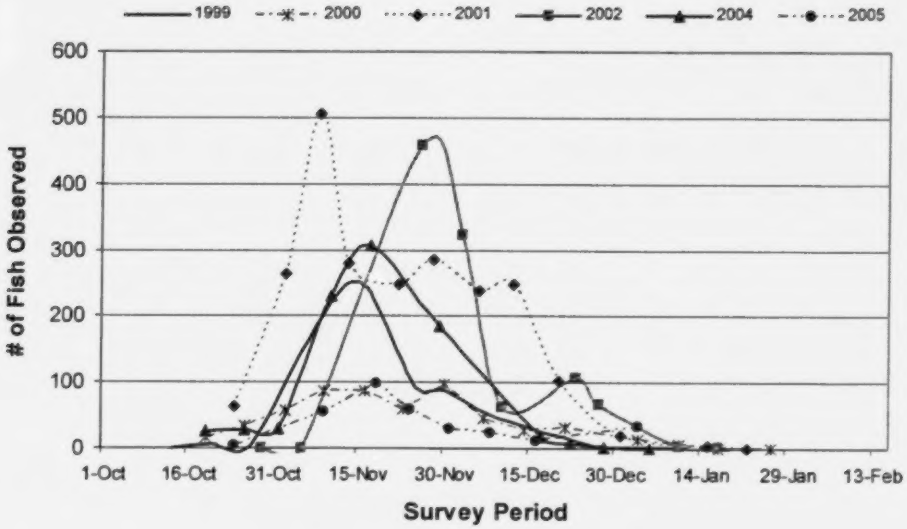
Survey Logistics: Four crew members (two vehicles) are required to survey Whonnock Creek due to accessibility of the surveyed area. To access the survey area, all crews drive east on Dewdney Trunk Road (towards Mission) and turn right on 272nd Street (south). They follow 272nd Street south and turn left on 112th Avenue and follow 112th Avenue to the Whonnock Creek bridge crossing. To survey segments 1 and 2, one crew (two crew members) park their vehicle at the 112th Avenue Whonnock Creek bridge crossing and survey from the 112th Avenue bridge crossing to the Dewdney Trunk Road bridge crossing (exiting and re-entering the creek between segments 1 and 2). To access segments 3 and 4, the two other crew members drive east on 112th Avenue and turn left (north) onto 280th Street. They follow 280th Street and turn left (north) onto 284th Street, follow 284th Street and turn left (west) onto Dewdney Trunk Road, and follow the road to the Whonnock Creek bridge crossing and park their vehicle. To survey segments 3 and 4, two crew members survey from the bridge crossing on Dewdney Trunk Road to the bridge crossing on 287th Street.

Proportion of Spawning Area: The area around Whonnock Lake is unsurveyable. The coverage of coho spawning area is assumed to be good to very good. There is a large unsurveyed portion of the creek downstream of the lower survey boundary that most likely contains chum spawning activity. The coverage of chum spawning area is assumed to be poor to moderate.

RESULTS

Observer Efficiency: Whonnock Creek had a moderate average O.E. (0.64 ± 0.14) for all segments and years assessed. Observer efficiencies were relatively consistent among survey segments. Segment 1 had a slightly lower O.E. (average: 0.58 ± 0.16) compared to segments 2 (average: 0.67 ± 0.12) and 3 (average: 0.66 ± 0.13). Visibility in segment 1 was mainly reduced by water clarity (dark tea-like colour), instream cover (deep pools and cutbanks), and poor lighting due to significant overhead canopy. Higher visibility in segments 2 and 3 are attributed to the excellent water clarity (clear water), minimal surface glare, and low gradient/slow flows. Visibility in segments 2 and 3 was reduced by instream cover (cutbanks, deep pools and instream woody debris).

Coho Salmon: Run timing for coho varied among years, beginning October 19 to November 26, peaking November 8-30, and ending December 28 to January 15. Peak visual counts ranged from 97-505 coho.



Coho escapements ranged from 135-1,408 in 1999 to 2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	666	444	1,721	1,206	938	165
10	599	400	1,549	1,085	844	148
11	**545**	**363**	**1,408**	**987**	**767**	**135**
12	500	333	1,291	905	703	124
13	461	307	1,191	835	649	114

Chum Salmon: For all years surveyed (1999-2005), escapement of chum into Whonnock Creek was negligible.

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.005 fish/m^2 (2005) to 0.035 fish/m^2 (2001), with an average of 0.018 fish/m^2 over 6 years. The greatest proportion of total coho observed (average: 0.47) and greatest density of coho spawners (average: 0.030 fish/m^2) were observed in segment 1. Spatial distribution appeared to be influenced by escapement into the system. During years of increased escapement (2001 and 2002), a greater proportion of coho spawners were observed in segments 2 (average: 0.41) and segment 3 (average: 0.35) as compared to segment 1 (average: 0.25). Spawning substrate may have been limiting in segment 1 during years with high coho escapement.

Spawning habitat was abundant in segments 2 and 3; benthic substrate was predominantly small gravel and cobble. In segment 1, spawning habitat was patchy and limited to intermittent deposits of small gravel. In all segments, instream cover abundant and the riparian buffers were moderate.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	segments 1 - 3 have limited habitat (cobbles/boulders)
Instream Cover		
Adjacent Land Use		
Residential	X	lower sections of segment 1 and segment 2
Agricultural		
Roads		
Riparian Buffer	X	limited in lower sections of segment 1 and segment 2
Stream bank erosion		
Garbage		
Spawning disturbance	X	since most of the creeks flow through residential properties, pets have unrestricted access to the creek
Beaver activity		
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

WIDGEON CREEK

Watershed Code: 100-0267-193-000-000-000-000-000-000-000-000-000

CREEK DESCRIPTION

Widgeon Creek is approximately 16 km long (~1.7 km surveyed) and flows south into Widgeon Slough, a side channel of the Pitt River located north of Port Coquitlam (Schubert 1982). The upper 10 km of this creek flows through a steep canyon, broadening out into several branches across a wide alluvial fan. The surveyed sections of the creek flow through undisturbed forested areas, with the lower sections flowing through the Widgeon Valley National Wildlife Area.

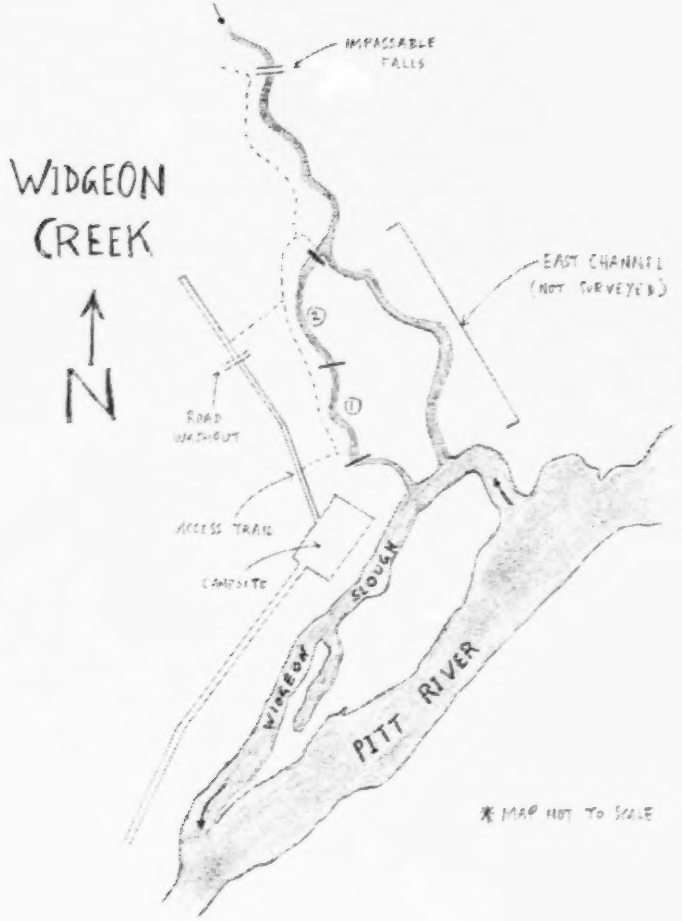
METHODS

Study Area: The survey area extends from approximately 300 m upstream of Widgeon Creek's confluence with Widgeon Slough (at the campground), north to the confluence with the east channel of Widgeon Creek. This creek was surveyed for coho from 2000 to 2004 (excluding 2002 and 2003) and for chum in 2001 and 2004. For all three survey years, upper and lower survey boundaries were identical; encompassing the area between the end of the slough (~ 300 m upstream of the campground) and the confluence with the east channel. In 2000 and 2001, the survey area consisted of one survey segment. In 2004, this segment was divided into two survey segments. Upper and lower survey boundaries were the same for all survey years. The surveyed segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Marker ~300M u/s of campground	49°22'43" N 122°38'24" W	marker	49°23'3" N 122°38'18" W	665	20-30
2	marker	49°23'3" N 122°38'18" W	confluence w/ east channel	49°23'25" N 122°38'11" W	980	20-30

Segment 1 extends 665 m from the marker located approximately 300 m upstream of Widgeon Creek's confluence with Widgeon Slough (at the campground), north (upstream) to the marker at the visible change instream bed characteristics (substrate size increases and channel width decreases). Spawning habitat for coho and chum is abundant throughout the segment; benthic substrate is predominantly large gravel and small cobbles interspersed with clusters of boulders. In this segment there is excellent instream cover that includes deep pools, instream woody debris, and cutbanks. The gradient increases noticeably in the upper sections and flows are moderate. Throughout this segment, there is an excellent riparian buffer of mixed-wood forest.

Segment 2 extends 980 m from the marker located where there is a noticeable change instream bed characteristics, north (upstream) to the confluence with the east channel of Widgeon Creek. Spawning habitat is limited in this segment; benthic substrate is predominantly cobbles and boulders. Some large sections in this segment are highly exposed with limited instream cover that includes cutbanks and instream woody debris. The gradient and flow are moderate. There is an excellent riparian buffer of mixed-wood forest.


WIDGEON CREEK
N
IMPASSABLE FALLS
EAST CHANNEL (NOT SURVEYED)
②
①
ROAD WASHOUT
ACCESS TRAIL
CAMPSITE
WIDGEON SLOUGH
PITT RIVER
* MAP NOT TO SCALE

Widgeon Creek sketch map (not to scale).

Survey Logistics: A minimum of two crew members are required to survey Widgeon Creek. To access the survey area, the crew drive west (towards Coquitlam) on the Lougheed Highway and turns right (north) onto Coast Meridian Road. On Coast Meridian Road, they follow the signs to Minnekhada Regional Park (trails) and then follow the gravel road through the Greater Vancouver Regional District (GVRD) Widgeon access gate to the campground and park their vehicle. To access the slough, both crew members follow the gravel road to the foot trail start (sign reads: to falls) and enter the creek following the trail of markers through the bush. To survey segments 1 and 2, the crew survey from the marker at the creek start to the confluence with the east channel and return to their vehicle via the Widgeon Falls trail.

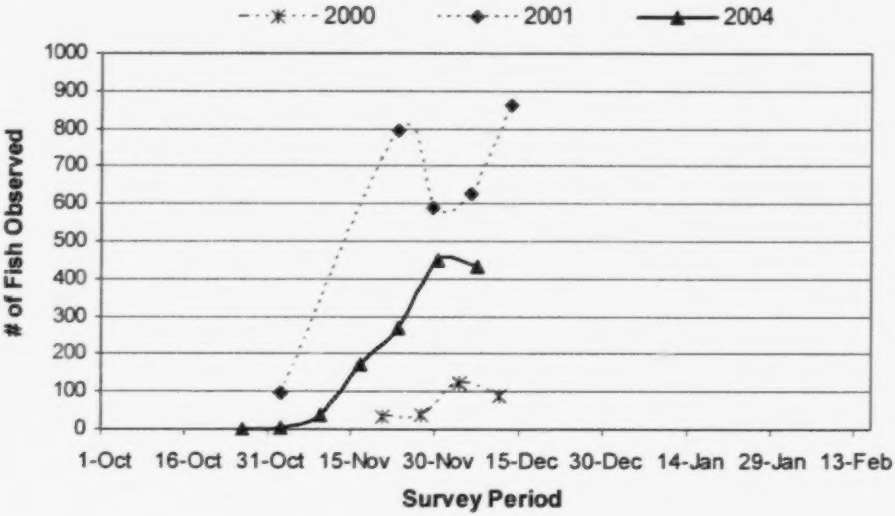
***NOTE:** Access to the survey area is limited by the Greater Vancouver Regional District (GVRD) gate; a key must be obtained.*

Proportion of Spawning Area: There are unsurveyed areas on this creek. The coverage of spawning areas, for both coho and chum, is assumed to be moderate.

RESULTS

Observer Efficiency: Widgeon Creek had a high average O.E. (0.71 ± 0.10) for all years assessed. The average O.E. for this creek's only segment was moderately high (0.71 ± 0.11). Above average visibility in this creek can be attributed to excellent water clarity (clear), substrate colour (high contrast among substrate and spawners) and limited instream cover. Visibility in this creek was reduced by large groups of fish (in pools), instream woody debris and surface glare.

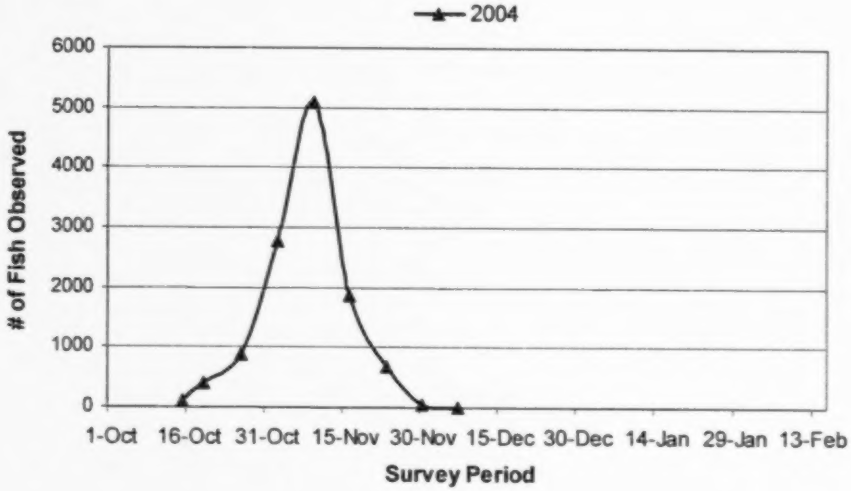
Coho Salmon: For all years surveyed (2000, 2001 and 2004), the complete run was not assessed. Since the data is incomplete, trends over time cannot be subjectively determined. Escapement estimates are presented but may not accurately reflect true coho abundance for each particular year.



Coho escapements ranged from 184-3,886 in 2000, 2001 and 2004 (R.T.: 11 days), however the data is incomplete and escapement estimates may not truly reflect abundance.

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	224	2,924	n/a	4,749	n/a
10	n/a	202	2,632	n/a	4,274	n/a
11	**n/a**	**184**	**2,393**	**n/a**	**3,886**	**n/a**
12	n/a	168	2,193	n/a	3,562	n/a
13	n/a	155	2,024	n/a	3,288	n/a

Chum Salmon: In 2004, chum were first observed on October 15 and last observed on December 7 (end of surveys). Peak spawning occurred on November 9 with a peak visual count of 5,083 chum. Run timing was unimodal.



Chum escapement in 2004 was 8,204. Assessment data from 2001 were not incorporated into the report as initial visual counts commenced well into the peak of chum spawning.

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	n/a	n/a	10,256	n/a
9	n/a	n/a	n/a	n/a	9,116	n/a
10	**n/a**	**n/a**	**n/a**	**n/a**	**8,204**	**n/a**
11	n/a	n/a	n/a	n/a	7,459	n/a
12	n/a	n/a	n/a	n/a	6,837	n/a

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.021 fish/m^2 (2004) to 0.035 fish/m^2 (2001), with an average of 0.028 fish/m^2 over 2 years. Chum spawner density, based on 2004 data, averaged 0.122 fish/m^2.

In 2004, when the survey area was divided into two segments, the greatest proportions of coho spawners were observed in segment 1 (0.78). Densities of coho were also greater in segment 1 in 2004 (0.038 fish/m^2).

Similarly, the greatest proportion (0.82) and greatest densities of chum (0.252 fish/m^2) were observed in segment 1. Most chum spawning activity was observed particularly in the lower sections of segment 1. For both coho and chum, spawning habitat did not appear to be limiting.

Spawning habitat for coho and chum was abundant in segment 1 and limited in segment 2.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	limited in segment 2 (boulders/cobbles)
Instream Cover	X	segment 2 is highly exposed
Adjacent Land Use		
Residential		
Agricultural		
Roads		
Riparian Buffer		
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity		
Miscellaneous		
Hatchery supplemented	No	not stocked for coho or chum

WORTH CREEK

Watershed Code: 100-unavailable (Nicomen Slough tributary)

CREEK DESCRIPTION

Worth Creek is approximately 655 m long and flows south from its headwaters (groundwater fed) into Norrish Creek and ultimately Nicomen Slough. The entire length of the creek is surveyed. During periods of high water, two tributaries develop that connect the upper sections of Worth Creek to the upper surveyed sections of Norrish Creek. This creek largely flows through agricultural and forested areas.

METHODS

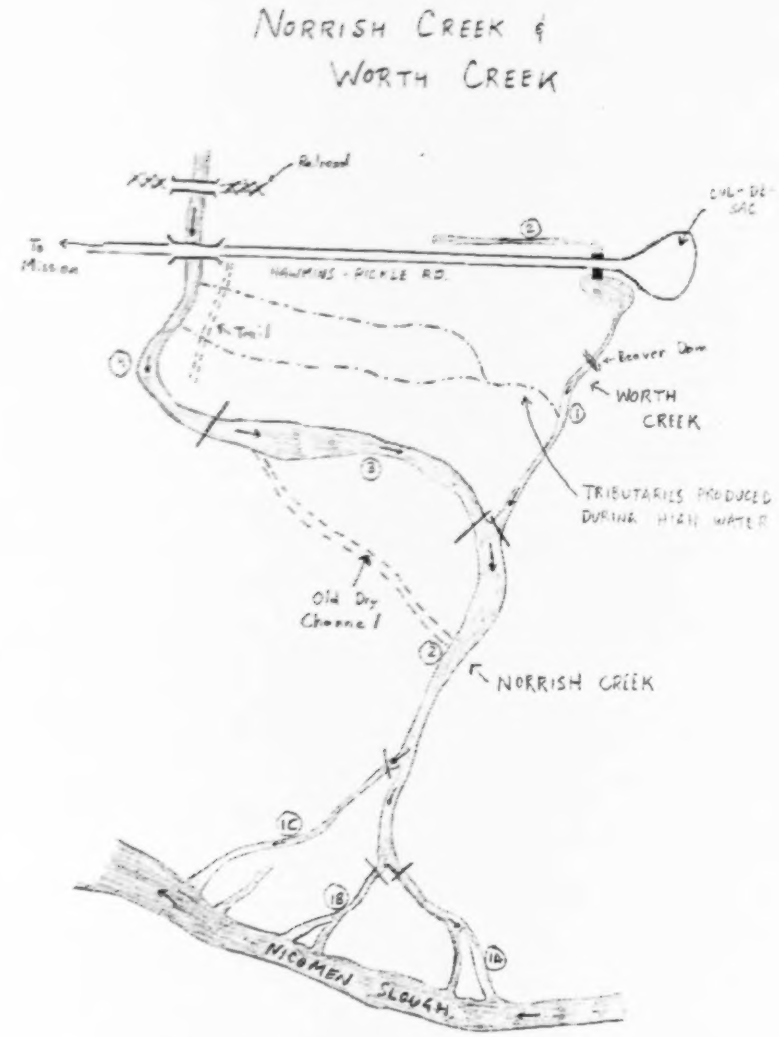
Study Area: The surveyed area extends from Worth Creek's confluence with Norrish Creek, north to Hawkins-Pickle Road (Mission) and includes a ditch that runs parallel to the road. This creek was surveyed for coho and chum from 2001 to 2004 (excluding 2003). In 2001, the survey area consisted of one survey segment (confluence with Norrish Creek to Hawkins-Pickle Road culvert). Late in 2002, an additional segment was added during periods of increased water flow; a ditch on the north side of Hawkins-Pickle Road. The survey segments are as follows:

Segment	Lower Boundary	Lower Coordinates	Upper Boundary	Upper Coordinates	Dist. (m)	~ Survey Time (min)
1	Mouth (into Norrish Creek)	49°10'30" N 122°8'33" W	Hawkins-Pickle Road culvert (south side)	49°10'36" N 122°8'35" W	465	20-25
2	Hawkins-Pickle Road culvert (north side)	49°10'36" N 122°8'35" W	end of creek	49°10'35" N 122°8'42" W	190	5-10

Segment 1 extends 465 m from its confluence with Norrish Creek, north (upstream) to the culvert on Hawkins-Pickle Road. In this segment, spawning habitat is limited to the upper sections; the benthic substrate is sand and silt in the lower sections, changing to small gravel and cobble in the upper sections. Streamside vegetation and limited instream woody debris provide cover for salmon. The gradient is low and flow is slow. This segment flows through agricultural and forested areas. There is a limited riparian buffer on both banks due to agricultural use in the area.

Segment 2 extends 190 m from the culvert (north side) at Hawkins-Pickle Road, west (upstream) to the end of the channel. This segment depends on rainfall events to increase water flow for fish passage. There is limited spawning habitat for coho and chum; the benthic substrate is small gravel. Streamside vegetation provides cover for salmon. The gradient in this segment is low and flow is slow. Since this segment parallels Hawkins-Pickle Road, there is no riparian buffer on either bank of this segment.

Survey Logistics: One crew member is required to survey Worth Creek. Due to its close proximity to Norrish Creek, Worth Creek and Norrish Creek are surveyed on the same day. To access the survey area, the crew drive east on the Lougheed Highway (#7) (Mission) to Hawkins-Pickle Road. They proceed through a 3-way intersection and follow Hawkins-Pickle Road, cross the train tracks (south), and park the vehicle at the Norrish Creek bridge crossing. To reach the mouth of Worth Creek, one crew member walks south on the foot trail (paralleling Norrish Creek) and surveys from the mouth of Worth Creek upstream to the culvert on the south side of Hawkins-Pickle Road. To survey segment 2, they cross Hawkins-Pickle Road to the north culvert and survey from there to the end of the channel.


NORRISH CREEK &
WORTH CREEK
Railroad
To Mission
HAWKINS - PICKLE RD.
CUL-DE-SAC
2
Trail
4
Beaver Dam
WORTH CREEK
1
3
TRIBUTARIES PRODUCED DURING HIGH WATER
Old Dry Channel
2
NORRISH CREEK
1C
1B
1A
NICOMEN SLOUGH

Worth Creek (and Norrish Creek) sketch map (not to scale).

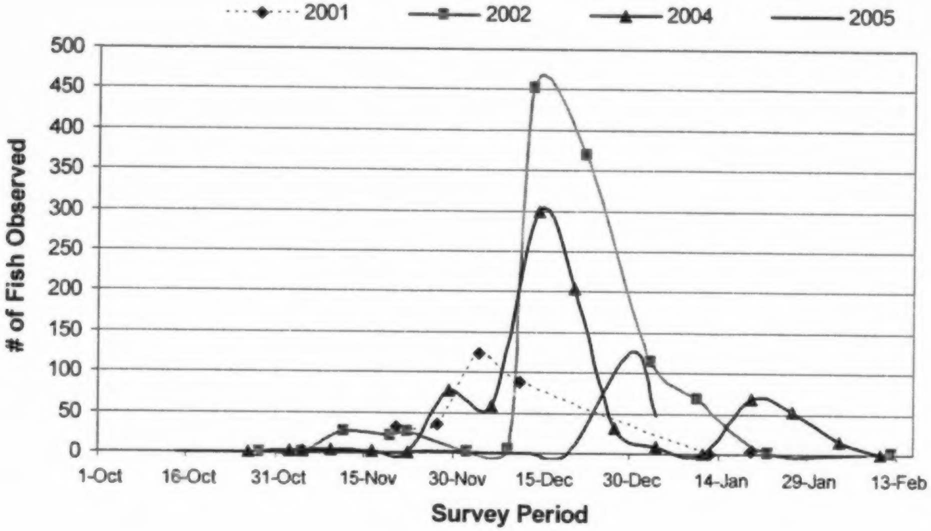
Proportion of Spawning Area: The creek is surveyed in its entirety. The coverage of spawning area, for both coho and chum, is excellent

RESULTS

Observer Efficiency: Worth Creek had a high average O.E. (0.80 ± 0.12) for all segments and years assessed. Observer efficiencies were relatively high and varied among survey segments; segment 1 had a lower O.E. (average: 0.75 ± 0.13) compared to segment 2 (average: 0.92 ± 0.04). Visibility in segment 1 is slightly lower due to large numbers of fish, interspecies mixing, and instream cover habitat (cutbanks and woody debris). The higher visibility in segment 2 can be attributed solely to channel characteristics (very shallow water and narrow channel widths).

Both segments have excellent water clarity, ideal substrate colouration (high contrast among substrate and spawners), and low gradient/slow flows.

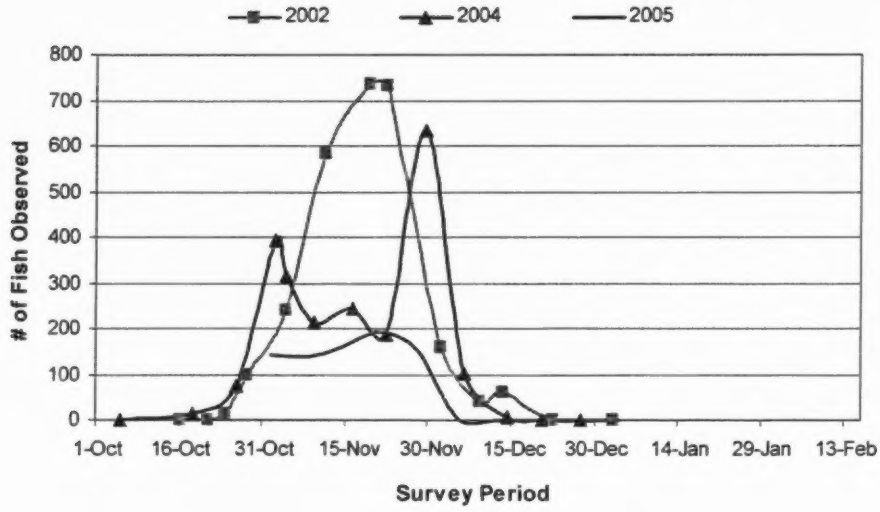
Coho Salmon: Run timing for coho was consistent among years, beginning November 2-11, peaking December 4-14, and ending January 30 to February 12. Peak visual counts ranged from 123 to 453 coho.



Coho escapements ranged from 193-1,982 in 2001 to 2005 (R.T.: 11 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
9	n/a	n/a	2,422	1,001	637	236
10	n/a	n/a	2,180	901	573	212
11	**n/a**	**n/a**	**1,982**	**819**	**521**	**193**
12	n/a	n/a	1,817	751	478	177
13	n/a	n/a	1,677	693	441	163

Chum Salmon: Run timing for chum was consistent among years, beginning October 18 to November 8, peaking November 2-29, and ending December 13-18. Peak visual counts ranged from 194-735 chum.



Chum escapements ranged from 443-1,740 in 2002 to 2005 (R.T.: 10 days).

Res. Time (days)	1999	2000	2001	2002	2004	2005
8	n/a	n/a	n/a	2,175	1,615	609
9	n/a	n/a	n/a	1,933	1,435	541
10	**n/a**	**n/a**	**n/a**	**1,740**	**1,292**	**443**
11	n/a	n/a	n/a	1,582	1,174	406
12	n/a	n/a	n/a	1,450	1,077	375

Spawner Densities: Among surveyed years, average coho spawner density ranged from 0.035 fish/m^2 (2004) to 0.145 fish/m^2 (2001), with an average of 0.075 fish/m^2 over 4 years. Average chum spawner density ranged from 0.031 fish/m^2 (2005) to 0.09 fish/m^2 (2002), with an average of 0.065 fish/m^2 over 3 years.

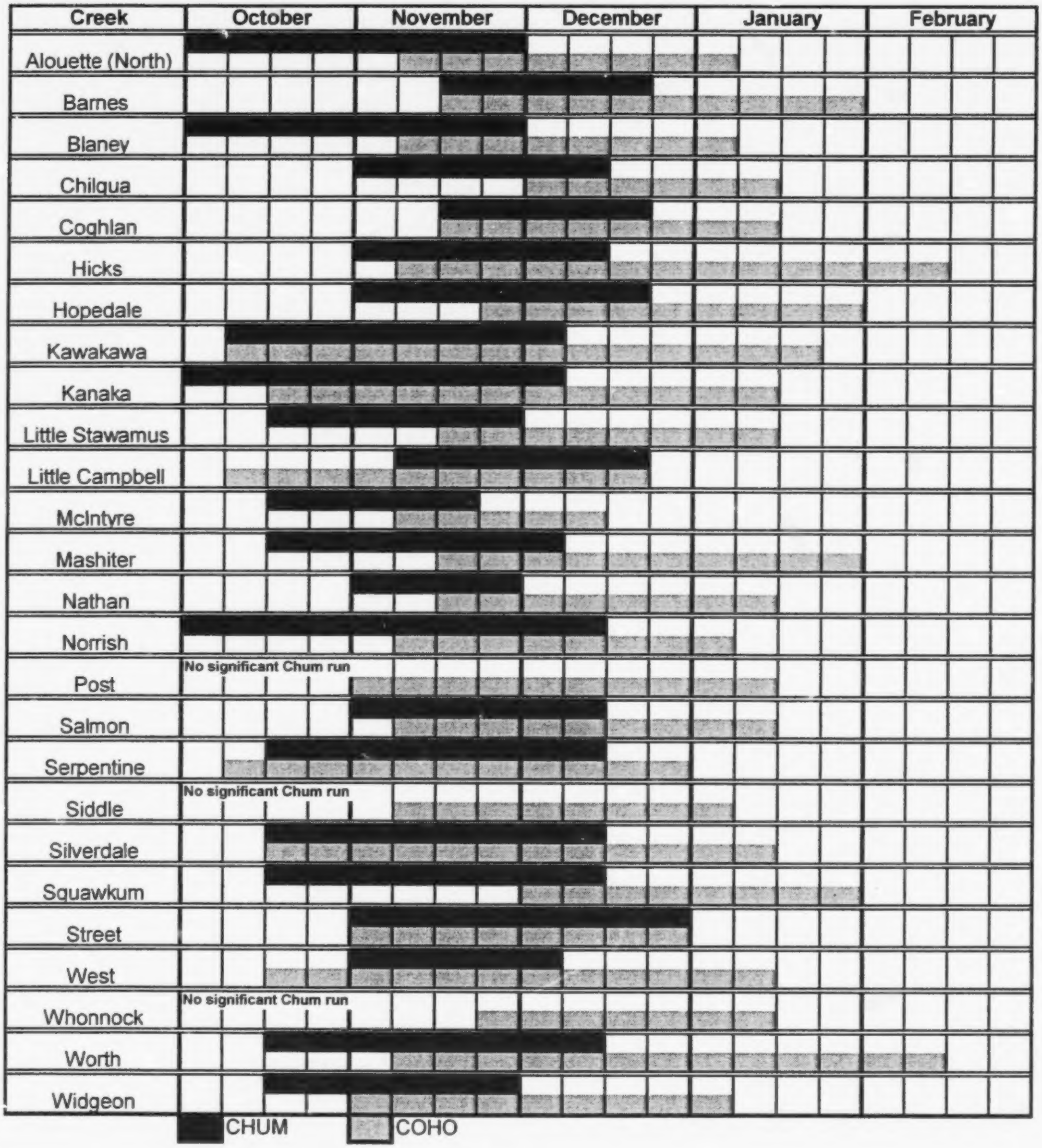
The greatest proportions of both coho and chum were observed in segment 1 (average: coho 0.79, chum 0.99). In segment 1, coho and chum spawning densities were low in the lower sections and high in the pool located at this segment's north end. Very little coho and chum spawning activity was observed in the lower sections of segment 1 where spawning substrate was limited. There was little competition for space for either species.

Spawning habitat was abundant for coho and chum in the upper sections of segment 1 and throughout segment 2.

	Concern	Comments
Flow/Gradient		
Spawning Substrate	X	segment 1 limited spawning habitat in lower sections (sand/silt); extremely limited in segment 2
Instream Cover		
Adjacent Land Use		
Residential		
Agricultural	X	segment 1 flows through agricultural areas
Roads		segment 2 parallels road
Riparian Buffer	X	limited in segment 1 (agricultural use) and 2 (road)
Stream bank erosion		
Garbage		
Spawning disturbance		
Beaver activity	X	a number of dams block upstream salmon migration
Miscellaneous		
Hatchery supplemented	**No**	not stocked for coho or chum

APPENDIX 'B'

Assessed LFA stream coho and chum average run timings.



APPENDIX 'C'

Survey Forms

Date:__________ Stream:______________ Observer(s): ________________ Page ___ of ___

Live Counts by Segment

Segment	Live Status	Species: Adult	Jack	Species: Adult	Jack		
	Hold./Migr.						
	Spawn.						
	Total						
	Hold./Migr.						
	Spawn.						
	Total						
	Hold./Migr.						
	Spawn.						
	Total						
	Hold./Migr.						
	Spawn.						
	Total						

Survey Start: Survey End:

Environmental Conditions

Water Properties	% Bankfull <25% 25-50% 50-75% 75-100% >100% — or —	
	Gauge:______ m	Water Temp:______ C
	Water Clarity 0-0.25m 0.25-0.5m 0.5-1.0m 1m-3m 3m or to bottom	
Sky Conditions	Brightness Full Bright Medium Dark	
	% Cloudy 0% 25% 50% 75% 100%	
Precipitation	Type Rain Snow None	
	Intensity Light Medium Heavy	

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[illegible] WATERPROOF

Carcass Recovery Sampling Data

Stream: Date: Observer(s):

Segment	Species	Sex			% Spawn	Carc. Cond.	POHL (cm)	Adipose Clip		Scale Sample		Comments (clip condition, DNA taken, head code)
		Male	Fem.	Jack				Yes	No	Book No.	Row No.	

APPENDIX 'D'

Assessed LFA streams' survey history

Coho / Chum Run Timings - Extensive Program Creeks, 1999-2005

				CHUM SALMON					*COHO SALMON*				
Creek	**Year**	**Survey Start**	**Survey End**	**First CM Obs.**	**# Obs.**	**Last CM Obs.**	**# Obs.**	**Peak Count**	**First CO Obs.**	**# Obs.**	**Last CO Obs.**	**# Obs.**	**Peak Count**
Alouette (North)	1999	not surveyed											
	2000	not surveyed											
	2001	**not available**		09-Nov	275	27-Nov	2	275	09-Nov	5	14-Jan	5	n/a
	2002	not surveyed											
	2003	not surveyed											
	2004	15-Oct	15-Dec	15-Oct	996	01-Dec	2	1092	04-Nov	12	13-Dec	70	70
	2005	not surveyed											
Barnes	1999	not surveyed											
	2000	not surveyed											
	2001	13-Nov	22-Jan	13-Nov	31	12-Dec	7	98	13-Nov	13	22-Jan	2	n/a
	2002	15-Oct	22-Jan	12-Nov	20	17-Dec	1	45	12-Nov	22	22-Jan	2	90
	2003	not surveyed											
	2004	06-Oct	26-Jan	05-Nov	7	03-Dec	3	72	05-Nov	7	19-Jan	3	28
	2005	12-Oct	03-Jan	04-Nov	11	05-Dec	2	50	18-Nov	3	30-Dec	45	34
Blaney	1999	15-Oct	21-Jan	**not assessed**					19-Nov	1	14-Dec	1	28
	2000	23-Oct	25-Jan	**not assessed**					06-Nov	2	27-Dec	1	3
	2001	23-Oct	23-Jan	23-Oct	857	23-Nov	28	2451	23-Oct	3	17-Jan	2	11
	2002	01-Oct	07-Jan	08-Oct	32	02-Dec	1	260	11-Nov	4	07-Jan	1	53
	2003	not surveyed											
	2004	30-Sep	28-Dec	06-Oct	22	17-Nov	311	1247	03-Nov	5	13-Dec	15	66
	2005	not surveyed											
Chilqua	1999	not surveyed											
	2000	not surveyed											
	2001	05-Nov	22-Jan	05-Nov	29	18-Dec	3	765	13-Nov	1	22-Jan	12	64
	2002	01-Oct	07-Jan	12-Nov	399	18-Dec	3	1064	03-Dec	3	14-Jan	11	87
	2003	not surveyed											
	2004	20-Oct	10-Feb	20-Oct	5	20-Dec	2	1079	04-Nov	1	03-Feb	7	172
	2005	08-Nov	11-Jan	08-Nov	36	12-Dec	11	310	30-Dec	23	30-Dec	23	23
Coghlan	1999	18-Oct	12-Jan	**not assessed**					01-Nov	19	05-Jan	1	103
	2000	18-Oct	22-Jan	**not assessed**					25-Oct	7	22-Jan	1	210
	2001	25-Oct	21-Jan	07-Nov	29	10-Dec	8	29	25-Oct	5	11-Jan	1	357
	2002	30-Oct	31-Dec	14-Nov	4	05-Dec	15	83	14-Nov	94	08-Jan	2	401
	2003	not surveyed											
	2004	25-Oct	01-Feb	09-Nov	84	07-Dec	7	84	09-Nov	312	31-Dec	2	312
	2005	21-Oct	11-Jan	21-Oct	4	29-Nov	9	80	09-Nov	9	04-Jan	13	63
Hicks	1999	not surveyed											
	2000	not surveyed											
	2001	31-Oct	26-Feb	31-Oct	47	23-Dec	3	617	31-Oct	2	26-Feb	1	643
	2002	09-Oct	11-Feb	19-Nov	410	13-Dec	8	410	19-Nov	13	11-Feb	16	327
	2003	not surveyed											
	2004	08-Oct	10-Feb	23-Oct	17	02-Dec	82	344	05-Nov	31	03-Feb	38	222
	2005	25-Oct	19-Jan	25-Oct	12	05-Dec	5	192	17-Nov	9	19-Jan	17	326
Hopedale	1999	15-Oct	21-Jan	**not assessed**					04-Nov	2	13-Jan	10	19
	2000	18-Oct	22-Jan	**not assessed**					04-Jan	11	24-Jan	12	23
	2001	23-Oct	30-Jan	23-Oct	105	31-Dec	8	1315	15-Nov	1	30-Jan	2	52
	2002	30-Sep	30-Jan	13-Nov	589	03-Jan	1	1111	20-Nov	4	20-Jan	8	31
	2003	not surveyed											
	2004	07-Oct	10-Feb	18-Oct	42	17-Dec	1	736	30-Nov	12	02-Feb	36	157
	2005	12-Oct	19-Jan	17-Oct	4	28-Dec	1	406	07-Nov	1	19-Jan	17	61
Kanaka	1999	not surveyed											
	2000	not surveyed											
	2001	09-Oct	21-Jan	09-Nov	2312	27-Nov	8	2312	09-Nov	31	21-Jan	16	198
	2002	08-Oct	23-Dec	08-Oct	983	08-Nov	6	3193	16-Oct	1	13-Jan	2	562
	2003	not surveyed											
	2004	05-Oct	05-Jan	06-Oct	2	01-Dec	34	2968	27-Oct	3	05-Jan	2	283
	2005	24-Oct	19-Jan	24-Oct	1819	08-Dec	1	1819	15-Nov	63	16-Dec	52	93
Kawkawa	1999	15-Oct	21-Jan	**not assessed**					28-Oct	16	21-Dec	7	16
	2000	18-Oct	22-Jan	**not assessed**					10-Nov	1	18-Jan	4	16
	2001	23-Oct	25-Jan	23-Oct	141	29-Nov	2	141	30-Oct	48	17-Jan	2	91
	2002	09-Oct	31-Dec	09-Oct	14	03-Dec	2	377	09-Oct	1	07-Jan	3	26
	2003	not surveyed											
	2004	01-Oct	05-Jan	08-Oct	30	12-Nov	66	219	03-Dec	6	23-Dec	11	12
	2005	not surveyed											

Coho / Chum Run Timings - Extensive Program Creeks, 1999-2005

				CHUM SALMON					COHO SALMON				
Creek	Year	Survey Start	Survey End	First CM Obs.	# Obs.	Last CM Obs.	# Obs.	Peak Count	First CO Obs.	# Obs.	Last CO Obs.	# Obs.	Peak Count
Little Campbell	1999	not surveyed											
	2000	not surveyed											
	2001	not surveyed											
	2002	not surveyed											
	2003	not surveyed											
	2004	17-Oct	02-Dec	22-Oct	2	02-Dec	25	48	17-Oct	5	02-Dec	66	209
	2005	not surveyed											
Little Stawamus	1999	19-Oct	18-Jan	not assessed					18-Nov	1	22-Dec	1	10
	2000	20-Oct	24-Jan	not assessed					10-Nov	1	18-Jan	2	2
	2001	22-Oct	07-Feb	30-Oct	6	05-Dec	2	54	06-Nov	4	30-Jan	2	21
	2002	02-Oct	31-Dec	13-Nov	39	04-Dec	7	102	13-Nov	16	20-Jan	1	72
	2003	not surveyed											
	2004	22-Oct	03-Dec	12-Nov	141	03-Dec	15	192	12-Nov	3	03-Dec	24	53
	2005	not surveyed											
Mashiter	1999	19-Oct	18-Jan	not assessed					26-Oct	1	22-Dec	5	5
	2000	20-Oct	24-Jan	not assessed					01-Dec	4	24-Jan	2	10
	2001	22-Oct	15-Feb	30-Oct	3	06-Nov	2	3	22-Nov	5	15-Feb	6	13
	2002	not surveyed											
	2003	not surveyed											
	2004	29-Oct	3 ded	29-Oct	2	03-Dec	2	264	12-Nov	2	03-Dec	7	7
	2005	not surveyed											
Mcintyre	1999	15-Oct	10-Jan	not assessed					15-Oct	4	21-Dec	9	211
	2000	23-Oct	23-Jan	not assessed					30-Oct	2	27-Dec	1	35
	2001	08-Oct	07-Jan	23-Oct	73	14-Nov	6	965	06-Nov	14	23-Jan	2	20
	2002	08-Oct	14-Jan	21-Oct	2	02-Dec	6	102	11-Nov	32	09-Dec	16	98
	2003	not surveyed											
	2004	30-Sep	13-Dec	06-Oct	4	07-Dec	1	801	02-Nov	3	13-Dec	9	57
	2005	not surveyed											
Nathan	1999	18-Oct	21-Dec	not assessed					18-Oct	1	07-Dec	46	89
	2000	18-Oct	23-Jan	not assessed					25-Oct	16	09-Jan	7	179
	2001	26-Oct	21-Jan	01-Nov	5	27-Nov	11	11	26-Oct	35	21-Jan	4	267
	2002	04-Oct	13-Jan	15-Nov	5	06-Dec	32	101	15-Nov	616	13-Jan	1	616
	2003	not surveyed											
	2004	21-Oct	03-Jan	04-Nov	34	13-Dec	1	44	28-Oct	51	22-Dec	3	160
	2005	21-Oct	11-Jan	21-Oct	3	29-Nov	1	32	09-Nov	31	20-Dec	6	99
Norrish	1999	not surveyed											
	2000	not surveyed											
	2001	08-Nov	22-Jan	08-Nov	1978	11-Dec	20	2656	08-Nov	1	22-Jan	4	160
	2002	07-Oct	10-Feb	07-Oct	49	22-Dec	4	1861	22-Nov	39	10-Jan	6	150
	2003	not surveyed											
	2004	01-Oct	03-Jan	01-Oct	2	06-Dec	21	8505	09-Nov	111	27-Dec	13	440
	2005	not surveyed											
Post	1999	14-Oct	25-Jan	No Chum Observed					14-Oct	15	10-Jan	42	416
	2000	23-Oct	25-Jan	No Chum Observed					23-Oct	5	25-Jan	5	115
	2001	22-Oct	24 jna	No Chum Observed					22-Oct	7	17-Jan	3	202
	2002	31-Oct	20-Jan	No Chum Observed					31-Oct	32	09-Jan	13	255
	2003	not surveyed											
	2004	15-Oct	25-Jan	No Chum Observed					23-Oct	8	04-Jan	84	192
	2005	27-Oct	05-Jan	No Chum Observed					27-Oct	8	05-Jan	23	51
Salmon	1999	18-Oct	26-Jan	not assessed					02-Nov	20	04-Jan	3	51
	2000	17-Oct	22-Jan	not assessed					24-Oct	10	15-Jan	18	390
	2001	25-Oct	23-Jan	02-Nov	4	10-Dec	1	4	25-Oct	23	14-Jan	3	240
	2002	30-Oct	21-Jan	14-Nov	15	05-Dec	20	63	14-Nov	226	21-Jan	1	1048
	2003	not surveyed											
	2004	25-Oct	31-Jan	25-Oct	6	07-Dec	3	26	23-Oct	4	10-Jan	1	211
	2005	not surveyed											
Serpentine	1999	not surveyed											
	2000	not surveyed											
	2001	not surveyed											
	2002	not surveyed											
	2003	not surveyed											
	2004	22-Oct	13-Dec	22-Oct	14	02-Dec	27	150	22-Oct	90	13-Dec	17	392
	2005	not surveyed											

Coho / Chum Run Timings - Extensive Program Creeks, 1999-2005

				CHUM SALMON					COHO SALMON				
Creek	Year	Survey Start	Survey End	First CM Obs.	# Obs.	Last CM Obs.	# Obs.	Peak Count	First CO Obs.	# Obs.	Last CO Obs.	# Obs.	Peak Count
Siddle	1999	not surveyed											
	2000	not surveyed											
	2001	05-Nov	22-Jan	05-Nov	3	05-Nov	3	3	05-Nov	53	22-Jan	7	255
	2002	09-Oct	16-Jan	14-Nov	6	29-Nov	3	6	12-Nov	1	10-Jan	6	166
	2003	not surveyed											
	2004	20-Oct	24-Jan	05-Nov	2	12-Nov	3	3	05-Nov	59	13-Jan	1	242
	2005	14-Oct	19-Jan	29-Dec	1	29-Dec	1	1	03-Nov	9	04-Jan	64	155
Silverdale	1999	not surveyed											
	2000	not surveyed											
	2001	13-Nov	22-Jan	13-Nov	365	11-Dec	3	319	13-Nov	8	15-Jan	4	24
	2002	10-Oct	13-Jan	10-Oct	203	09-Dec	7	2027	14-Oct	1	13-Jan	1	106
	2003	not surveyed											
	2004	30-Sep	03-Jan	06-Oct	99	01-Dec	25	2611	27-Oct	27	20-Dec	10	67
	2005	13-Oct	11-Jan	13-Oct	312	28-Nov	20	936	24-Oct	1	03-Jan	20	20
Squawkum	1999	not surveyed											
	2000	not surveyed											
	2001	not surveyed											
	2002	07-Oct	13-Feb	10-Oct	8	18-Dec	56	6062	25-Nov	2	31-Jan	7	38
	2003	not surveyed											
	2004	08-Oct	10-Feb	08-Oct	23	23-Dec	1	6455	29-Nov	2	04-Feb	11	100
	2005	12-Oct	05-Jan	12-Oct	58	23-Dec	1	5291	25-Nov	1	05-Jan	21	25
Street	1999	14-Oct	20-Jan	not assessed					21-Oct	3	13-Jan	2	4
	2000	20-Oct	24-Jan	not assessed					11-Jan	3	24-Jan	2	3
	2001	23-Oct	30-Jan	23-Oct	97	31-Dec	12	572	13-Dec	1	30-Jan	7	11
	2002	30-Sep	20-Jan	22-Oct	6	27-Dec	8	904	31-Oct	1	03-Jan	4	6
	2003	not surveyed											
	2004	07-Oct	10-Feb	18-Oct	6	23-Dec	2	846	30-Nov	2	02-Feb	1	6
	2005	not surveyed											
West	1999	not surveyed											
	2000	not surveyed											
	2001	23-Oct	23-Jan	01-Nov	28	12-Dec	4	97	07-Nov	79	09-Jan	2	79
	2002	26-Oct	21-Jan	not assessed					26-Oct	40	16-Jan	1	228
	2003	not surveyed											
	2004	not surveyed											
	2005	not surveyed											
Whonnock	1999	13-Oct	19-Jan	not assessed					20-Oct	2	06-Jan	1	158
	2000	19-Oct	26-Jan	not assessed					19-Oct	13	10-Jan	5	73
	2001	24-Oct	22-Jan	08-Nov	2	08-Nov	2	2	24-Oct	19	15-Jan	1	183
	2002	08-Oct	17-Jan	No Chum Observed					26-Nov	321	10-Jan	3	321
	2003	not surveyed											
	2004	19-Oct	05-Jan	No Chum Observed					19-Oct	14	28-Dec	1	148
	2005	24-Oct	11-Jan	24-Oct	8	24-Oct	8	8	24-Oct	2	03-Jan	24	73
Widgeon	1999	not surveyed											
	2000	23-Oct	25-Jan	not assessed					20-Nov	24	19-Jan	3	98
	2001	02-Nov	25-Jan	02-Nov	2345	06-Dec	2	2345	02-Nov	19	25-Jan	7	555
	2002	not surveyed											
	2003	not surveyed											
	2004	15-Oct	07-Dec	15-Oct	79	07-Dec	8	4117	09-Nov	31	07-Dec	346	388
	2005	not surveyed											
Worth	1999	not surveyed											
	2000	not surveyed											
	2001	02-Nov	30-Jan	08-Nov	327	18-Dec	4	327	02-Nov	4	30-Jan	32	423
	2002	07-Oct	12-Feb	24-Oct	12	13-Dec	56	698	11-Nov	16	12-Feb	2	408
	2003	not surveyed											
	2004	05-Oct	10-Feb	18-Oct	13	14-Dec	3	508	02-Nov	1	03-Feb	14	168
	2005	14-Oct	19-Jan	14-Oct	32	19-Jan	2	184	28-Nov	1	19-Jan	3	174